A STUDY OF THE TIME SPENT ON TEACHING GEOMETRY IN THE ELEMENTARY SCHOOL AND ITS RELATIONSHIP TO TEACHER ATTITUDES TOWARD GEOMETRY

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by

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ABSTRACT

This study was motivated by numerous reports of grade nine students experiencing difficulty with geometry, coupled with the increased emphasis being placed on geometry in the mathematics program for elementary grade children in the past decade.

The main purpose of the study was to investigate the relationship between elementary school teachers' attitudes toward geometry and the amount of time they spent teaching geometry. Since geometry is well represented in the mathematics program presently in use in the elementary schools, a minimum of six or seven weeks would be required to complete the recommended program. An important aspect of this study was to determine if elementary school teachers were spending the required amount of time to adequately cover the topics recommended for each grade level. Other concerns of the study were overall elementary teacher attitudes toward geometry, teacher experience with and preparation to teach certain geometric topics, method of instruction in geometry, teacher familiarity with manipulative aids for instruction in geometry, and any differences in attitude or time that might exist between urban and rural areas of the province.

The sample consisted of fifty-one rural and fifty-three urban teachers in the province of Newfoundland. Each teacher was administered a questionnaire. Upon completion of the questionnaire, a personal interview was conducted with each teacher. The teachers' responses to the questionnaires were used to analyze all aspects of the study other

than time. A second instrument was administered to compile information relating to the number of weeks the teachers sampled spent teaching geometry.

A low positive correlation was found between teacher attitude toward geometry and the amount of time spent teaching geometry. The overall attitude of the teachers toward geometry was found to be neutral at worst. Probably the most significant finding of the study was that the teachers reported a mean time spent on geometry of just slightly over two weeks. No significant differences were found between teachers of rural and urban areas.

The data collected on teacher preparation to teach, and experience with, certain topics in geometry indicated a strong relationship between the two. Teachers who were unfamiliar with certain topics in geometry expressed a reluctance to include them in their mathematics program. The areas teachers most often indicated unfamiliarity with were motion geometry, symbolic logic, three-dimensional geometry, and co-ordinate geometry.

While many teachers expressed their belief that an elementary school geometry program should be activity oriented, they were, in most cases, unfamiliar with the teaching aids available to assist in the instruction of geometry.

Several suggestions were made for further research. These suggestions, along with a more thorough discussion of the findings of this study, are contained in the final chapter of the study.

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CHAPTER I

THE PROBLEM

> It is generally agreed that geometric ideas do not receive adequate attention in the elementary schools. The emphasis is usually on computation. This neglect is unfortunate and short sighted. Not only are geometric ideas important in their own right, but they can contribute to the learning of other mathematical topics, including computation. (p. 447)

Carpenter, Coburn, Reys, and Wilson (1975) introduced their report of the results of the National Assessment of Educational Progress (NAEP) with the above statements. In comparison with the mathematics curriculum prior to the 1960's, the curriculum in the 70's is rich with geometry. The fact that this is so, however, does not necessarily mean that more of the time spent on mathematics is now being devoted to the teaching of geometry.

Robinson (1966) pointed out that geometry is an important subject in its own right and should be introduced at the elementary level.

> It is unrealistic to postpone the study of geometry until it can be approached in a systematic and rigorous way. Precision and rigor can best be appreciated when we understand what we are being precise and rigorous about. (p. 3)

Most mathematics educators would agree that geometry should be part of the elementary school mathematics curriculum, but there is much disagreement about what, how much, and in what depth geometry should be studied in the elementary grades. Certain teachers recommend that geometry should be included as part of the curriculum for enrichment purposes, to be done if time permits. Others feel that geometric concepts are useful in developing computational skills and problem solving abilities. Many teachers feel that it is important that geometry be treated as part of the core program at every grade level, and that appropriate attention be given to the introduction, development, and maintenance of important geometric concepts. If, however, teachers are confused as to what to cover, they may very well end up doing little, if any, geometry.

Confusion on the part of the teacher can only lead to similar confusion with the student. Evans (1965) pointed this out in the following statement:

> Attitudes can be and are learned. What forms they will take is not determined at birth or earlier, but depends on the environment in which the child grows up and the treatment he receives. (p. 16)

While it is important that a teacher be aware of the content to be covered in a course, it is also very important that a well-developed teaching strategy accompany it. Palardy (1969) indicated the importance of a well-developed program and a clear method of instruction in the following statements.

> One can hardly expect a teacher to put full effort into the utilization of a teaching method which he does not consider sound or personally congenial. The latter factor may become a much more important determinant of what happens than differences in prescribed patterns. (p. 373)

In a recent study carried out in three large elementary schools in St. John's by McGrath (1977) it was found that geometry was considered a problem area at all levels of mathematics education prior to secondary school. The main reason given for this condition was the fact that prior to grade nine the students had little, if any, exposure to geometry. When it was first introduced at a grade seven or eight level, the students experienced difficulty in coping with the program. They became bombarded with definitions, concepts, and drawings all at once. These aspects of geometry should have been introduced gradually up through the grades. It was also suggested by McGrath that leaving the decision to do geometry or not to do geometry in the hands of the teachers could result in gaps in the experiences of the children which could lead to more serious problems in later grades.

When one refers to elementary school geometry, people often get different impressions of what is being referred to. To some, it might imply the introduction of high school geometry in the elementary schools in a somewhat simpler form. To others, it may simply mean that drill should be provided in geometric vocabulary. Both geometric concepts and vocabulary have a place in an elementary mathematics curriculum, but neither should constitute the entire program. One of the major aims of an elementary geometry program should be to develop a well-organized concept of space. The Cambridge Conference Report (1963) listed as one of its major aims for elementary school geometry the following:

> to develop the planar and spatial intuition of the pupil, to afford a source of visualization for arithmetic and algebra, and to serve as a model for that branch of natural science which investigates physical space by mathematical methods. (p. 33)

Teachers often tend to think of geometry mainly as consisting of Euclidean "proofs." This is but one small area of the realm of geometry. Geometry was first developed for practical purposes when man was required to observe different shapes in his environment, and to make crude measurements. While Euclid has received the credit for most of the geometry that existed in our schools until recently, his main contribution was the organization of many geometric ideas already known to man. His geometry consisted of definitions, axioms, and theorems of plane and solid geometry. The course that developed from this type of study consisted mainly of memorizing proofs of specific theorems and being able to perform basic constructions. Little was left to the imagination of the student. Today's geometry teachers in Newfoundland, as elsewhere, are challenged to present a more "modern" geometry, more alive, and less formal. Many geometry chapters in elementary textbook series in use today appear to be changing from a traditional to a transformational approach to the topic.

Lesh (1976) stated five criteria that could be used to justify teaching a topic related to mathematics in elementary school.

> (a) The topic may be considered to be important in its own right--without any "outside" justification.
>
> (b) The topic may contribute to or reinforce other important topics.
>
> (c) The topic may simply be fun and serve the function of luring children into enjoying mathematical problem solving experiences.
>
> (d) The topic can help prepare children for higher level mathematics.
>
> (e) The topic may have important "real-world" applications.

The remainder of this section will deal with each of these five statements individually, indicating how geometry can be applied to each of them.

Geometry is Important in Its Own Right

Geometric forms enter into the life of every child regardless of the grade, and can be viewed as a principal means of developing the mental faculty of sense perception. Trafton and LeBlanc (1973) point out that a child's constant contact with an implicitly geometric environment, together with his interest in the geometric elements of his world, provides a natural and fertile foundation that is psychologically appropriate for development in a more explicit manner with children. Hence this development is considered to be important to the concept of learning. The subject matter of geometry is both suitable and important for an elementary mathematics program. The Final Report of the National Education Association Committee of Fifteen on Geometry (1912) stated that:

> The ability to control geometric forms is unquestionably a real need in the life of every individual, even as early as the graded school. For those who cannot proceed further, the need is pressing.

Trafton and LeBlanc (1973) stated that: "The qualitative aspects of children's reasoning have long been recognized as an integral part of mathematics education" (p. 30).

Powers of reasoning do not always come naturally with children. There are important skills such as inquiry, discovering relationships, formulating and testing conjectures, and critical and analytical thinking, that can and should be taught. This may best be accomplished by involving children in activities suited to their age and stage of mental development. Geometry lends itself very well to this aspect of learning.

Geometry Can Contribute to the Reinforcement of Other Important Topics

Elementary teachers often tend to think of geometry units as being isolated from the remainder of the curriculum. This is not the case. Robinson (1966) points out:

> Certain sets of points have the property of connectedness. This property of being connected is closely related to the concept of fraction, and basic to the concept of measurement. (p. 9)

When we teach area and volume we make use of basic geometric shapes; models and number lines are often used to introduce fractions; and similar triangles are used to illustrate proportions. Piaget and Beth (1966) claim that logical, arithmetic, and geometric concepts each arise out of a common source, which is children's interactions with concrete materials. Geometry at the elementary level would provide appropriate exposure to such materials.

One of the major aims stated in the Cambridge Report (1963) was that geometry should be taught to afford a source of visualization for arithmetic and algebra. Williford (1972), in his analysis of research carried out in the area of geometry, noted a significant relationship between success in geometry and general reading ability and mathematics achievement. He also reported that fifth graders who were taught coordinate geometry showed significant gains on a test of map and graph understanding.

Geometry is Fun and Serves the Function of Luring Children into Enjoyable Mathematical Problem Solving Experiences

Since most of the geometry in the elementary school texts often involves laboratory-type activities, children being curious by nature, enjoy manipulating objects and investigating geometric shapes and relationships. The fact that many teachers see geometry as something they can use to break from usual classroom activities is a good indication that children enjoy it.

Children enjoy work with tangrams, geoboards, and other geometric teaching aids, and are quite willing to become involved with problem solving situations where they can actually "see" the solutions. Students whose interests are not awakened by numbers often have an affinity for geometr Certain children tend to think in spatial rather than quantitative terms. Trafton and LeBlanc (1973) indicated a general agreement among educators that elementary school pupils find exposure to geometry a pleasurable experience.

Geometry Can Help Prepare Children for Higher Level Mathematics

Many of the problems children face in their dealings with secondary school geometry stem from the fact that they have not been adequately prepared at the elementary level. This was evident in the study conducted by McGrath (1977). Secondary teachers often assume that children are familiar with such terms as sphere and cube when teaching geometry. However, to many students a sphere is a circle, and a cube a square. These distinctions are crucial and should be made at the elementary level. Students, through the manipulation of objects, can often discover many of the physical characteristics of geometric shapes. The Final Report of the National Education Association Committee of Fifteen on Geometry (1912) stated that:

> For those who are going on to the high school, the development of the appreciation of geometric forms is almost an absolute prerequisite for any future work in geometry. (p. 89)

The mere handling of geometric devices such as a compass or a metrestick produces within the child an awareness of the functions and limitations of such instruments. There are skills in using such mathematical tools that can be mastered at the elementary level.

The elementary school child is capable of developing a strong feeling for geometric relationships in space. Too often by the time he gets into secondary school his feelings for geometric space are flattened by years of work at a two-dimensional blackboard and on two-dimensional sheets of paper.

One strong argument for articulation between elementary and high school geometry, as pointed out by Robinson (1966), is the fact that teaching geometry in the elementary schools presents much of the compartmentalization of content into an unrelated collection of "facts." Such compartmentalization neither reflects the nature of mathematics, nor contributes to the mathematical development of the student. A study of geometry at the elementary level is important to the overall development of geometry. The elementary school should provide the student with experiences in geometry that would be later organized at the junior high level. These organized experiences would then form the basis for a more formal senior high program.

Trafton and LeBlanc (1973) point out that:

> It is appropriate that pupils gain an early awareness of basic concepts of geometry, and also develop an appreciation of the breadth of this discipline of mathematics. (p. 34)

Thus, an early exposure to geometry helps provide the student with an appreciation for the subject as a whole, rather than fragmented portions of it. Students will soon come to realize that geometric ideas can be used to develop and classify ideas in other areas of the mathematics curriculum, as was pointed out in an earlier section.

Geometry Has Important "Real World" Applications

To describe our world requires us to recognize shapes, sizes, and relationships. Geometry is the organized study that teaches us to recognize these attributes. Whether it be similarity involved in ratio and proportion, in similar triangles, or in the leaves on a tree, or the symmetry of the multiplication table, of the square, of the butterfly, or some other attributes, geometry fits the picture very well.

Geometry offers the child some form of explanation of the physical world around him. Geometric ideas are an integral part of nature's design and the physical world. In the study of geometry the interplay between mathematics and the physical world can be effectively and naturally described. There is much evidence to indicate that children often learn by manipulating their environment, and geometry can provide the vehicle for this manipulation.

Educators have often emphasized the importance of being able to relate the learning of mathematics to the physical world, particularly with young learners. The study of geometry provides an avenue for the interplay between mathematics and the real world to be effectively and naturally emphasized. Geometry tends to organize and describe what children have already informally encountered. Trafton and LeBlanc (1973) state:

> A child's constant contact with an implicitly geometric environment, together with his interest in the geometric elements of his world, provides a natural and fertile foundation that is psychologically appropriate for development in a more explicit manner with children. (p. 29)

How a serious mathematics teacher could overlook the overwhelming benefits a child can derive from early exposure to geometry, is baffling to say the least.

Carpenter et al (1975) suggested that not only should geometry be taught in the elementary grades, but in the upper and lower elementary grades, geometry should take on somewhat different roles.

> Successful performance in applying geometric relationships depends, to a large extent, on a sound initial development of the basic concepts and terminology in the early elementary grades. The responsibility for developing a high level of performance with many of the key geometric concepts contained in the assessment exercises should fall on the upper elementary through junior high school grades. (p. 449)

The foregoing suggests that teaching geometry in the elementary school is very important, and should involve, to a large degree, the teaching of geometric concepts extracted from the child's experience with familiar objects. The child's familiarity with the space in which he lives and with the objects in that space, plus his imagination, are the raw materials for assisting him to build a strong geometric intuition.

PURPOSE OF THE STUDY

McGrath (1977) found that in many cases geometry was not being taught in the elementary grades in the three schools that he sampled. These findings were similar to conclusions of the NACOME Report (1975) which indicated that although geometry was mentioned as being part of texts, objectives, and testing, 78% of the teachers reported spending fewer than fifteen class periods per year on geometry topics.

Geometry is part of the required core program for elementary schools and thus should be given the same consideration as other topics contained in the core. This study attempted to further investigate the findings of McGrath (1977) and the NACOME Report (1975) on the amount of time being spent on geometry by elementary school teachers in the province of Newfoundland for the school year 1978-1979. Another main consideration of this study was to investigate the relationship between the attitudes of elementary school teachers toward geometry and the amount of time spent teaching geometry. More specifically, answers were sought to the following questions:

(i) What are the attitudes of elementary school teachers toward geometry?

(ii) Are there any differences between the attitudes of elementary school teachers in rural and urban areas of Newfoundland toward geometry?

(iii) How many weeks do elementary school teachers spend per year teaching geometry?

(iv) Are there any differences between the number of weeks elementary school teachers in rural and urban areas of Newfoundland spend teaching geometry?

(v) Does a relationship exist between elementary school teachers' attitudes toward geometry and the number of weeks they spend teaching geometry?

(vi) What personal experience do elementary school teachers possess with regard to certain areas of geometry?

(vii) How well-prepared are elementary school teachers to teach certain areas of geometry?

(viii) What percentage of time spent on geometry do elementary school teachers feel should be activity oriented?

(ix) How familiar are elementary school teachers with the materials available to aid in the teaching of geometry?

RATIONALE FOR THE STUDY

Traditionally, geometry was omitted from the elementary school mathematics program, and introduced at the secondary level. Because of changes in the past decade emphasizing the unity of mathematics, geometry has been included in the required mathematics curriculum of the elementary school. Consequently, the mathematics program presently in use in our elementary schools contains sufficient geometry. The recommended time to be allocated to geometry according to the authors of the Investigating School Mathematics Program (ISM) for grades three to six is approximately seven weeks. This time allotment has been substantiated by a number of prominent mathematics educators at Memorial University of Newfoundland.

However, McGrath (1977) found that the elementary schools he sampled were not giving geometry the coverage that had been recommended. The introduction to the problem at the beginning of this chapter established that geometry has a place in the elementary school mathematics curriculum. Since there are a certain number of topics to be covered in the program, the amount of time spent teaching geometry is directly related to the coverage given the topics. Hence, time spent teaching geometry is important if one believes that the mathematics program for our schools should be unified.

A second major consideration of this study was the relationship of elementary school teacher attitudes toward geometry and the amount of time spent teaching geometry. The remainder of this rationale will deal with the justification for including attitudes in this study.

Phillips (1973) indicated that the weight of expert opinion seems overwhelmingly to favour the view that teacher's attitude toward mathematics is an important factor in the learning of mathematics. The extent to which it is a factor, and the aspects of learning most affected by teachers' attitudes, are not clear and definite. Begle (1979), in looking at research conducted in mathematics education, commented on the small number of studies that had been done relating teacher attitude to both student attitude and student achievement. He felt that more research had to be done before firm conclusions could be reached.

If there exists any shadow of doubt about the effect teachers' attitudes have on education, then there exists a reason for studying this area. Hann (1961) felt very strongly about the importance of teachers showing favourable attitudes toward mathematics. He writes:

> The large number of teachers who dislike or fear mathematics has become a factor in children's attitudes toward the subject. The effects of teachers' attitudes are widespread. Like all other attitudes, dislike of mathematics is readily communicated to children either directly or unconsciously. It contributes to the routinized teaching of mathematics and also to outright neglect. (p. 201)

These same feelings are expressed by others. Stone (1959) stated that "an enduring fear and hatred of mathematics if installed at the elementary level, can rarely be overcome later on in high school" (p. 177). Phillips (1973) indicated that already there are too many prospective teachers who have negative attitudes toward a subject they will be required to teach" (p. 501). One cannot but assume that teachers' attitude toward a subject will have a bearing on the way in which the subject is taught and how well it is taught. Their willingness to approach the subject with enthusiasm, being always on the alert for new ideas and new teaching strategies, may well be influenced by their attitude.

Farley (1976) pointed out that a teacher needs to exert necessary leadership, so that the students know exactly what is expected of them. To do this, a teacher must possess a feeling of security and understanding for mathematics, and a favourable attitude to foster these feelings. Letwiller (1968) indicated that:

> A teacher reflects her attitude toward a subject as she teaches it. A teacher who feels insecure in mathematics, for whom mathematics is mostly rote manipulation, with little understanding, transmits these feelings to her students. On the other hand, the teacher who has confidence, understanding, interest and enthusiasm in mathematics also transmits these feelings to her students. (p. 345)

Aiken and Dreger (1961) and Aiken (1970), in their review of educational research relating to attitudes, concluded that of all the factors affecting student attitudes toward mathematics, experience with former mathematics teachers was found to be an important factor in present student attitudes toward mathematics. Deighan (1971) found similar results.

Teacher attitudes are not the only factors that affect student attitudes and student achievement. An unhealthy attitude toward mathematics may result from a number of causes. Banks (1964) cited the following as being important:

> Parental attitudes may be responsible; repeated failure is almost certain to produce a bad emotional reaction to the study of arithmetic; attitudes of his peers will have their effects upon the child's attitude. But by far, the most significant factor is the attitude of the teacher. (p. 39)

Hence, teacher attitude toward a subject is worthy of consideration, since it may be responsible, in part, for the outcome. Should a teacher express an unfavourable attitude toward geometry, indicating a lack of enthusiasm of the subject, the amount of time spent on the topic may very well be affected. This study was designed to investigate this relationship.

DESCRIPTION OF THE STUDY

The two main purposes of the study were, to determine the time spent on teaching geometry in the elementary schools, and to investigate its relationship to teacher attitudes toward geometry. Other concerns investigated included, teachers' personal experience with certain areas of geometry and how well prepared they felt to teach these same areas, method of instruction, familiarity with geometric manipulative aids, and any differences that might exist between rural and urban teachers relative to time or attitudes.

One hundred four elementary school teachers from rural and urban areas of the province took part in the study. Each teacher was administered a questionnaire (Appendix I). When the questionnaire had been completed, each teacher was personally interviewed during which time instrument B (Appendix II) was used to determine the amount of time each teacher spent teaching geometry.

The research design was basically a survey carried out personally by the interviewer, using the two instruments referred to above. The data collected from these two instruments was used to answer the questions put forth in the purpose of the study.

LIMITATIONS

This study was designed to determine the time spent on teaching geometry in the elementary schools and to investigate the relationship between elementary school teacher attitudes toward geometry and the amount of time spent teaching geometry. The study was carried out in the province of Newfoundland for the year 1978-1979. It was virtually impossible to include all the teachers in the population in the study or all areas in the province. Hence, the following delimitations were imposed:

(1) Teachers sampled were from grades 3-6 inclusive. No consideration was given to teachers below grade three or above grade six. Hence, the study can be generalized only for these particular grades.

(2) The geometry in this study referred to the geometry contained in the Investigating School Mathematics program (ISM) by Eichols, O'Daffer and Fleenor.

(3) The sample was chosen from only selected urban and rural areas of Newfoundland. Since personal interviews were conducted, all areas of the province could not be reached in the time available.

(4) Placing the ranking of the topics in mathematics after the attitude section of the questionnaire might cause the ranking to be influenced by the questionnaire itself.

(5) The presence of the interviewer might have temporarily lifted the respondent out of his natural social context.

(6) The method of data collection may have influenced the way the teachers responded to the questions they were presented with. If they believed the researcher possessed a favorable attitude toward geometry, they may have tended to indicate a more positive attitude themselves than they would otherwise indicate.

(7) Having the teachers indicate the amount of time they spent teaching geometry after they had completed the questionnaire, may have put them on the defensive, especially if they had not done much geometry with their class.

OUTLINE OF THESIS

A review of selected relevant literature will be presented in Chapter II. Chapter III describes the design of the study, the instrumentation, and the methods used to analyse the data. The results, interpretations and conclusions of the study are provided in Chapter IV. Chapter V provides a summary of the study, discusses the results and implications, and suggests further research areas to be studied.

CHAPTER II

REVIEW OF RELATED LITERATURE

The literature reviewed in this chapter is divided into three sections. In the first section the works of Piaget as they relate to the ways in which a child discovers relationships about the space in which he lives, and how he perceives geometric concepts are reviewed. Also the mental development of the child and its importance to the way a child learns geometry is discussed.

In the second section other literature on learning and teaching geometry is reviewed. In the introduction of this study it was pointed out that geometry has its place in an elementary mathematics curriculum. This review deals with what geometric concepts are relevant to elementary school children and can be learned by them, the types of activities that can best be used to teach these concepts, the method(s) of instruction most appropriate to use when teaching geometry, and the competency of elementary school teachers to teach geometry.

The final section deals with the question of attitudes. Since this study was not directly concerned with the relationship of attitudes to achievement, this component of the research on attitudes was omitted. The literature reviewed dealt with general attitudes of students and teachers toward mathematics, and the relationship of teacher attitudes to student attitudes.

The purpose of the review of literature is to provide the reader with a better understanding of the relevant research preceding this study, and provide further evidence of the need for this study.

Piaget has probably been more instrumental than any other individual in influencing the teaching of elementary school mathematics. Two major pieces of work that have had considerable influence on the teaching of geometry are, The Child's Conception of Space, and The Child's Conception of Geometry.

Piaget claims that a child's first geometrical discoveries are topological. Not until a considerable time after he has mastered topological relationships, does he begin to develop his notions of Euclidean and projective geometry. In short, Piaget claims that the child's conception of space and geometry proceeds in an invariant sequence of topological concepts through projective concepts and finally to the development of Euclidean concepts. While topological space deals with the external relations of the isolated object, projective space deals with the relation of the objects to the subject, and Euclidean space deals with the relation of objects to objects.

Smock (1976) summarized this development as follows:

> To summarize, geometry is the science of space. The child's notion of space changes with development. At first, the child only is able to conceive of space in terms of such relationship as neighbourhood, order, betweeness and closure. Later, he learns to construct space by a 'point of view' of the observer(s), and to describe space in terms of left-right, before-behind, and above-below. At the final stage, the child can conserve distance, and with the aid of a coordinate system, begins to conceive space in metric terms. (p. 66)

Much of Piaget's work has been replicated by Page (1958), Lovell (1959), Dodwell (1963, 1970), as well as others. Their findings, where they can be substantiated, tell us much about the type of geometry program we should be using in our elementary schools. Hence, in this part of the literature review some of the studies carried out relative to The Child's Conception of Space and The Child's Conception of Geometry are examined.

Page (1958) conducted a replication of Piaget's haptic perception experiment with children from three to eight years of age. His results generally concurred with Piaget's. However, the children in his study achieved success at a younger age than did those of Piaget.

Lovell (1959) carried out replications of six of the experiments in The Child's Conception of Space, including the haptic perception experiment. Lovell's subjects ranged from approximately three to six years of age. His results were the same as those of Page (1958), and generally in all the experiments the subjects achieved success approximately one year less than the ages indicated by Piaget. Lovell also concluded that variability of performance within age groups was far greater than that reported by Piaget.

Shantz and Smock (1966) found that first grade children developed the ability to conserve distance prior to the understanding of the Euclidean coordinate system. This is consistent with the work of Piaget.

Dodwell (1963) replicated seven of the experiments in The Child's Conception of Space. Three of these corresponded to those conducted by Lovell. Unlike Piaget and Lovell, Dodwell conducted each of his experiments with each child in his sample. The children ranged in age from five to eleven. Again the results of Piaget were substantiated in general. It is of some importance to note that although the overall ability to deal with spatial concepts improved with age, no clear cut progression from one type of thinking about space to another could be identified.

One must be careful in interpreting the results of studies carried out using Piagetian tasks. They should not be interpreted to mean that the Piagetian tasks should be brought into the mathematics classroom. Rather, the significance of these results merely indicate that Piaget's levels of development should be kept in mind when an elementary mathematics curriculum is planned. Many of the activities should be provided at a time when the child can benefit most from them.

Many replications of Piaget's work in relation to <u>The Child's Conception of Geometry</u> have also been carried out. Lovell, Healey, and Rowland (1962), Helmore (1969), Page (1973), Beilin and Franklin (1962), and Bailey (1974), to mention just a few, have all done replications of some of the experiments in Piaget's book.

Lovell, Healey and Rowland (1962) replicated 12 of Piaget's experiments with both primary (ages 5-9) and Educationally Subnormal (ESM) Special School Children (ages 9-15). The experiments were concerned with distance relations, conservation and measurement of length, locating a point in two-dimensional space, angular measurement, and area relationships, among others. They concluded that the main stages of Piaget were broadly confirmed. However, as with Lovell's (1959) previous work, the number of children at various stages was more variable than indicated by Piaget. Some children appeared not to pass through intermediate stages of development but proceeded from stage one to three directly. The ESN children were found to be a 4-7 years behind the average primary school child. Perhaps this indicates that intelligence is an important variable in the development of a child's conception of geometry.

Helmore (1969) also replicated six of the experiments reported by Lovell et al above. His results were similar, particularly with respect to variations in performance at each age level. As with all the Piagetian studies mentioned this far, the ability to do the tasks increases with age. Again the implications of the Lovell and Helmore studies is that even though students may be able to learn some tasks by rote at an early age, it is questionable that they have an understanding of the concepts. Teachers must therefore make a sincere effort to determine each child's stage of development and proceed accordingly.

Page (1973) replicated five of the experiments from The Child's Conception of Geometry with Zula youths aged 11-20. The school experience of these youths ranged from no schooling to seven years of primary school. Page reports that only youths who grow up in town and attend school from an early age, and who consequently associate the invariances of formal measurement with their "carpentered world" environment are able to progress from the essentially egocentric, topological concept of space to the objective abstractions of the Euclidean one. This plus the related findings that the Zula youths attained the levels of development at a considerable later age than did Piaget's subjects, suggest that perhaps factors such as schooling and environment have more effect on the development of the conception of geometry than others would indicate.

This review has been designed to give the reader some appreciation of the work of Piaget relative to space and geometry. Even if one accepts Piaget's conclusions, one must proceed with extreme care and caution, remembering that each child is different and many factors, other than age, influence child development.

Piaget yields some important observations and research relevant to geometry. The work of Piaget (1951, 1952, 1964) contains many suggestions on how children develop and how they learn geometric concepts. He points out that an individual's failure to grasp most basic concepts stems from affective emotional blocking or inadequate preparation, rather than lack of any special aptitude. This leads to the very important need to provide the learner with concrete experiences and practical action at the appropriate stage of development.

GEOMETRY

Geometry has been a subject of much controversy in the 1960's and 1970's, and many articles have been written on the topic. A major source of these articles has been the Mathematics Teacher and the Arithmetic Teacher. However, many of these articles have been of a descriptive nature, containing content to be taught and some suggestive methods of "how" geometry should be taught. A collection of the best articles to appear in the Arithmetic Teacher on the teaching of geometry has been published in a book of readings, Readings in Geometry from the Arithmetic Teacher. This book was first published in 1970, then reprinted in 1971 and updated in 1972, by the National Council of Teachers of Mathematics (NCTM). The book is very thorough, containing three sections, one on involvement, one on instructional techniques, and a third on instructional rationale. In addition to this, another source of readings in geometry is the 36th yearbook of the NCTM (1973) which is devoted entirely to geometry, with reference to all levels of geometry education. However, very few of the articles in either of these sources are research oriented.

If much research has been done on the teaching of elementary school geometry, very little has been reported. Neither Glennon and Callahan (1968) nor Spitzer (1970) devote any space to the topic in their rather extensive research reports on Elementary School Mathematics. Riedesel and Burns (1973) devote only one paragraph of a twenty page report to studies on geometry and make reference to only seven articles. Thus it would seem that more people are interested in sharing experiences than documenting research.

One of the most complete reports on the topic is that done by Williford (1972). His references include almost forty dissertation and research reports. A brief summary of his findings are given in point form below. A complete report can be found in Appendix IV at the end of this study.

(a) A majority of very young children possess a variety of geometric skills.

(b) More geometry topics have been included in text materials, especially in the upper elementary grades since the turn of the century.

(c) Classes taught by teachers achieve more than those taught through programmed instruction.

(d) Use of a large amount of concrete materials produced the best results in the middle elementary grades.

(e) A significant relationship between success in geometry and general reading and mathematics achievement was found.

(f) Some evidence indicated that the geometric knowledge of elementary school pupils was significantly related to their teacher's knowledge.

(g) A variety of geometry topics can be taught to elementary school children.

Several studies are available which indicate that young children can learn spatial concepts. Brumbaugh (1971) reported that 3, 4, and 5 year olds could match solid figures with both photographs and sketches of the solids. Also, Sister Josephine (1964) found that children 3, 4, and 5 could recognize geometric shapes, distinguish between terms such as up, down, across, corner, long, short, and could work with spatial relations such as separation, overlapping, tangency, inside, outside, big, and small. Recognition was increased by increasing exposure to the concepts. The evidence suggests that experience with shapes and related concepts is effective in improving the ability to be successful on related tasks. The implication for early (primary and elementary) education are quite evident in that experiences with shapes and their properties are worthwhile activities for young children.

Dienes (1966) emphasized that many different situations must be provided in order to enable children to make abstractions. He states that the child must experience the actual situations. He further emphasized that if the proper stimulus situations are presented, children can engage in highly sophisticated logical thinking. Dienes' ideas seem to support the hypothesis by Bruner (1960) that any subject can be taught to any child at any level in some honest form. Bruner points out the importance of translating mathematics to the child's way of thinking. That is, the ideas should be presented in a concrete form at an early age and become more abstract as the child's thinking processes mature.

Both linear and area measurement are geometric concepts requiring a Euclidean concept of space. Bailey (1974) investigated the ability of first, second, and third graders to learn linear measurement concepts. He concluded that before a child can use the substitution property of length relations he must be able to engage in transitive reasoning involving length relations. This ability is usually developed by eight years of age. Another important conclusion was that the ability to simultaneously use the dimensions of length of units and number of iterations to logically establish a length relation between two polygonal paths appears after the age of nine. These results indicate that some care needs to be exercised in attempting to teach linear measurement to primary school children. Similar results to the above are reported by Carpenter (1975), although in a somewhat different context.

Beilin and Franklin (1962) report that before instruction, very few first graders achieve operational length measurement, but, however, most third graders do have success. After training there was some improvement in the first grade children's performance. The performance of the third grade students improved with training, however many children still had difficulty. The authors hypothesized that the concepts of linear measurement, area measurement, and volume measurement develop in that order. Volume measurement does not develop until after age 12, and therefore should not be dealt with extensively in the elementary school.

Lovell (1970) studied the abilities of 5-10 year olds to use and manipulate measuring instruments to compare the areas of two shapes that differed in appearance. The results indicated that children of age 10 experienced little difficulty with the tasks, however younger children experienced more difficulty. Lunzer (1968) reported that children had considerable difficulty dissociating area and parimeter before age 14. Again, the implications for elementary school are that these concepts must be treated with great care. Provision must be made to provide the children with appropriate experiences when they are required.

Holloway (1960), in reviewing the work of Piaget, listed three levels of achievement that could be distinguished in the construction of Euclidean space. The first is represented by the qualitative operations in conservation of distance, length, area, and interior volume, and the conservation of congruence in the process of transfer from one position to another. The second level involves the achievement of simple operations, the measurement of length in one, two, and three dimensions, the construction of metric coordinate systems, and a first beginning of the measurement of angles and areas. The final level is reached when areas and volumes are calculated. Only now is mathematical multiplication used. This is done to coordinate the results of multiplicative logical operations and simple measurement, and only at this stage is there conservation of volume relative to the surrounding spatial medium. The first two levels fit very nicely the elementary geometry program.

Weaver (1966), Shah (1967), and Denmark and Kalin (1964) all present results which indicate certain geometry concepts can be learned by elementary school children. Weaver administered an inventory which he claims measured the ability to classify plane geometric figures in terms of selected non-disjoint categories to grade 4, 5, and 6 pupils. He concluded that children enrolled in "contemporary programs" scored higher than those enrolled in "conventional programs." The implication is that elementary school children can learn to classify plane geometric figures if they are in a program where non-metric geometry is an integral part of the program.

Shah (1967) found that after two weeks of instruction, pupils within the age range eight to eleven were able to satisfactorily learn concepts related to matching polygons to numbers, nets of solids, simple transformations, bending and stretching of two- and three-dimensional figures, and networks. Seven to eight year olds experienced more difficulty with these concepts.

Denmark and Kalin (1964) examined the possibility of teaching geometric constructions in grade five. They concluded that the students could successfully bisect an angle, construct the perpendicular bisector of a line segment, copy a triangle, construct a perpendicular to a line from a point on the line, and copy a quadrilateral. They experienced more difficulty in comparing size of angles, dropping a perpendicular to a line from a point not on the line, constructing squares and rectangles, and constructing similar figures. They concluded that more geometry can be taught in grade 5 than is presently the case. However, care must be taken when students are required to use the compass to insure proper technique is developed.

D'Augustine (1964) attempted to identify geometrical topics which were teachable to grade six students. He concluded that the following topics, interior, exterior, boundary points, congruency, simple closed curves, properties and definition of a triangle, collinearity, countable and uncountable sets of points, properties of lines, line segments, and broken lines, were highly teachable after presenting the material in a programmed text over a one week period. In a later study (1966) he used programmed lessons to teach the concepts of paths and their properties, simple closed curves, and polygons to fifth, sixth and seventh graders. He discovered that reading and overall mathematics ability were significantly related to success in learning geometry.

Hence, there is no question that elementary school children can learn geometry, given an opportunity to do so. In a study done by Schnur and Callahan (1973) they found a considerable variance in the learning geometric behaviours of elementary school children. However, many children showed considerable proficiency with geometry.

If we agree that elementary children can learn geometry, then which method of instruction, if any, is the best to use? Stoll (1962) determined that the rate at which kindergarten children learn simple geometric concepts is directly related to the number of representative models present at the time of stimulus presentation. This finding is somewhat different from the results of Bassler and Frayer (1966). Perhaps, more examples are necessary for concept mastery with younger children than with older children.

Genkins (1970) constructed a unit dealing with the study of symmetry. Kindergarten subjects who were taught by the use of paper-folding techniques scored significantly higher on an achievement test than those who were taught by the use of mirrors. This result did not hold true at the second-grade level or with the combined data for kindergarten and second graders.

Cheatham (1969) compared compass and straightedge methods versus paper-folding methods in the construction of solid models at the seventh grade. He found no significant achievement differences between treatment groups after two weeks of instruction. The results of this study together with those of Genkins (1970) suggest that perhaps paper-folding techniques are more appropriate for kindergarten children than for older children.

Scott, Frayer, and Klausmeier (1971) attempted to compare discovery and expository methods in teaching certain geometric concepts (including triangles and quadrilaterals). They found that expository methods were superior for short-term retention measured immediately or one day after instruction, but discovery learning was superior for long-term retention measured twenty-one days after instruction. The implication here is that the choice of teaching method (expository or discovery) might be determined by the desired results (immediate or long-term).

Henderson and Rollins (1967) investigated three strategems for teaching mathematical concepts and generalizations by guided discovery using concepts of plane geometry with grade 8 students. The strategems involved the use of the agreement of instances of the concepts and generalizations taught, the similar use of disagreement, and a combination of the previous two. The results indicated no differences in achievement using the three procedures. It is concluded that curriculum writers interested in inductive strategies need not limit themselves to one approach only. The results may well also be applicable to the elementary school, however more research is needed to support this claim.

A study by Armstrong (1969) indicated that sixth graders learned geometry equally well with two modes of a spiral curriculum. The two modes were topical spiraling where either a particular subset of an area was returned to periodically and one where the entire area was recycled. Miller, Boismier, and Hooks (1969) found an activity program more beneficial than an automated program in training second grade children in spatial operations. A combination of the two programs was better than the automated but inferior to the activity program.

Hence we can conclude that there are many options open to the classroom teacher of geometry, each with its strengths and weaknesses. The method chosen must reflect the teacher involved, the content being considered and, above all, the children in the classroom.

Having considered the questions of whether children of elementary school age can learn geometry concepts, and the appropriate strategy, one area of concern remaining is competency of elementary school teachers with respect to mathematics, and geometry in particular.

Weaver (1966) administered the same inventory to elementary school teachers as he used with grade 4, 5, and 6 students in a study reported earlier. Of his three groups of teachers, one group showed considerable unfamiliarity with the terms polygon, quadrilateral, rectangle, and simple closed curves. The other groups who had been exposed to more geometry did much better. The need to provide the teachers with more experiences, either through inservice or university courses appears evident.

A study conducted by Wardrop (1972) found that supplementing a geometry course taken by prospective elementary teachers with geometric enrichment exercises did not improve either their achievement or attitude. A poor attitude towards geometry by the teacher may cause some difficulty in teaching the subject to the students.

The study by Bassler (1966), reported earlier, used students enrolled in a geometry course designed for elementary education majors. On a posttest the mean achievement scores ranged in the area 75-80% correct. However, on a retention test the mean scores were less than 50%. When one considers that these other studies were conducted with junior high and elementary school children using the same objectives, the situation becomes critical. Either the objectives are too difficult for the younger children or the teacher trainees are very weak on the particular type of mathematics. Considering that the school children did almost as well as the teachers, unfortunately the fault may be with the teachers.

ATTITUDES

ATTITUDES TOWARDS MATHEMATICS

Attitudes towards mathematics have been a great concern of many educators. It is not necessary for students to like an activity or subject in order to use it, but most educators agree that anything done to influence a student should leave him with a favourable feeling.

A problem of the definition of the term "attitude" becomes evident when interpreting research concerning the measurement of attitudes towards mathematics. Aiken (1972) states that "terms such as attitude, value and appreciation refer to the affective objective of instruction" (p. 229). He further points out that the best definition can be found in an examination of the instrument used in a study. The most common instruments appear to be the Thurstone and Likert Scales and the Semantic Differential.

Knaupp (1973) observed that the lack of clarity in defining attitudes becomes a crucial problem in examining research done on student attitudes in mathematics. He notes that the resulting problems are caused by using crude measuring instruments, excessive reliance on correlational methods, improper use of covariance analysis, inadequate control of extraneous variables, failure to measure change over time, lack of clear definition of the type of attitude being studied, and use of students, especially young students who often lack language facility and objectivity.

Student Attitudes Toward Mathematics

Straight (1956), in a study of 1 023 students in grades 4, 5, and 6, reported that 80% of the students really liked mathematics. However, he questioned whether the self-reported responses reflected "true" feelings or "expected" feelings. Herman (1963), in a similar survey of the subjects least liked by a group of fourth, fifth and sixth graders, found that arithmetic was typically in the middle when the subjects were ranked from least to most preferred.

In two separate studies Rowland and Innskeep (1963) found that children at the intermediate grade level tended to rank arithmetic in first place. Chase and Josephina (1959) have indicated that children at the elementary level rated arithmetic as the second best liked subject. Of the least liked subjects Sr. Josephina found that arithmetic was rated first, but Rowland and Innskeep found it was ranked third.

Dutton and Blum (1968) constructed and used a Likert-type scale to study the attitudes of 346 elementary school children who had at least one year of new mathematics. They found that about 30% of the pupils had favourable attitudes towards the new mathematics, 53% were neutral, and 17% disliked the subject a great deal. The study also confirmed findings of other studies that younger children have more positive attitudes than do older children when using new mathematics. The children were found to have ambivalent feelings towards mathematics.

Begle (1973), in a summary of two longitudinal studies conducted by SMSG, stated that:

> Student attitudes towards mathematics seem to be favorable at the beginning of the fourth grade and improve slightly during the remainder of elementary school. However, at the beginning of junior high school, student attitudes towards mathematics begin a slow but steady drop that continues to the end of high school. (pp. 212-13)

Investigations by Osborn (1965) and Woodall (1966) noted that these attitude changes were not affected by the nature of the curriculum to which the students had been exposed.

Lyda and Morse (1963), in a study of fourth grade students using the Dutton Arithmetic Attitude Scale, concluded that when meaningful methods of teaching arithmetic are used, changes in attitudes toward arithmetic take place. Negative attitudes become positive and the intensity of positive attitudes becomes enhanced.

Earle (1973) reported that students have a better attitude toward mathematics in general than they do toward geometry. Introducing isolated units at the elementary and junior high levels does not improve attitudes nor achievement. What is needed is a more integrated approach to geometry.

Summary. Children in the primary and elementary grades tend to rank mathematics among their three best liked subjects. At this level their attitude toward mathematics tends to be more positive than negative. Although attitudes may be developed as early as third grade, they are often superficial and easily changed. Lasting attitudes are more often formed at the junior high level. At the senior high level, attitudes tend to be less positive toward mathematics than at the elementary and junior high level. Often by this time it is ranked in third place or lower in preferred subjects. Children's attitudes toward mathematics and, in fact, school subjects in general, become increasingly less positive as they progress through school.

Teacher Attitudes Toward Mathematics

Begle (1979), in his findings from a survey of empirical literature, noted that elementary school teachers seemed to have attitudes toward mathematics which were neutral at worst. Gearhart (1975) found somewhat similar results for secondary mathematics teachers.

Straight (1960), in his survey of third, fourth and sixth grade teachers, found that a large percentage, somewhat over 90%, stated that they really enjoyed teaching arithmetic, and felt that arithmetic was of great value. However, 21% felt they could teach arithmetic well without reading periodicals and methods books.

Collier (1969) noted that most elementary school teachers possessed very formal views of mathematics prior to university training. He pointed out that after two content courses and a methods course, their views became slightly more informal. He also indicated that if informal attitudes are desirable, they should be established early, during the content courses.

Cox (1970) and Keith (1970) both found that the knowledge of elementary teachers relative to geometry was somewhat deficient in some areas. Cox also found that pupils gain scores in mathematics were related to the teacher's knowledge of the subject. Keith found that younger teachers with less experience were better prepared to teach geometry than older teachers with more experience.

Gearhart (1975) found that, in general, teachers who had studied or taught a topic tended to be more interested in its inclusion in the geometry course, and believed that more students could learn the material. Also revealed in this study was the finding that the number of years in teaching mathematics was significantly correlated with the teacher's perception of student attitudes and achievement. Teacher's background in mathematics was also found to be positively correlated with their feelings of preparation to teach new mathematics and their intent in doing so.

Nugent (1967), in surveying 670 elementary and junior high teachers, found an overall attitude toward mathematics which was slightly favourable. He noted that the attitude of women was often more favourable than that of men and the attitude of the younger age group more favourable than that of an older age group.

Early (1969) reported that prospective elementary teachers who selected grades 4-6 as areas they preferred, possessed significantly higher attitudes toward arithmetic than those teachers who selected the primary (K-3) level.

Dutton (1954) and Smith (1964), using the same scale to measure the attitudes of elementary school teachers toward mathematics, found that less than 10% of the teachers studied disliked the subject, approximately 20% were neutral toward it and approximately 70% showed a favourable attitude toward mathematics.

Summary. There is ample evidence to indicate that elementary school teachers do not possess an unfavourable attitude toward mathematics. What this means in terms of a desirable or undesirable characteristic of an elementary school mathematics teacher, has not been firmly established. The relationship between teacher attitude and student attitude and teacher attitude and student achievement is still unclear. Evidence can be found to support or reject these relationships.

TEACHER ATTITUDE--STUDENT ATTITUDE

Haan (1961) stated that the large number of teachers who dislike or fear mathematics has become a factor in children's attitude toward the subject. The effects of teacher attitudes are widespread. Like all other subjects, dislike of mathematics is readily communicated to children either directly or unconsciously. It contributes to routinized teaching of mathematics and also to outright neglect.

Philips (1973) stated that student attitude toward arithmetic is significantly related to the type of teacher attitude encountered by the students for all of his past three years. Students, all of whose last three teachers indicate a favourable attitude toward arithmetic, show more favourable attitudes toward that subject than do students having had three successive teachers with unfavourable attitudes.

Keane's (1969) findings were inconclusive in establishing relationships between teachers' attitudes and students' attitudes toward mathematics. His finding did reveal that teacher attitude has no effect on student achievement and that economic environment affects student attitude toward mathematics but not achievement. There were no significant relationships between mathematical concepts and mathematical problem solving on the Iowa Test of Basic Skills and student attitudes toward mathematics in the 25 000+ population towns among any of the socioeconomic groups. There were significant relationships among the rural area schools.

Leach (1961), Garner (1963), Peskin (1964), Letweller (1968) and Aiken (1970) all found a positive relationship between teacher attitude and the attitude of the students they taught.

Leach (1961) indicated that a child's success in arithmetic and his attitude toward arithmetic are basically dependent upon the teacher's attitudes and the methods they employ. He further stated that teachers at all grade levels should be aware of pupils' attitudes toward arithmetic and should strive to use the teaching methods that would help develop favourable attitudes toward arithmetic.

Garner (1963) found significant relationships between the attitudes and feelings of competency of teachers in his study and the attitudes and feelings of competency of the students as follows:

(a) teacher's background in mathematics and student achievement,

(b) teacher's attitude toward mathematics and the attitude of their students, and

(c) teacher's and student's judgments concerning the value of mathematics.

Similar findings were reported by Peskin (1964). In studying the relationship of teacher attitudes and understanding of mathematics to attitudes and understanding of the students in nine New York City schools, he found:

(a) correlations between the teacher's and their students' understanding of mathematics were significantly positive,

(b) significant correlations between the attitudes of the teachers and the attitudes of their students toward mathematics.

Letweller (1968) and Aiken (1970) both reported teacher attitudes as being an important factor in the formation of student attitudes, especially at the elementary level.

Gilbert and Cooper (1976), in their investigations of the relationship between teacher and student attitudes, reported a negative correlation. They found a more important factor in formation of student attitudes to be the teacher's attitude toward working with children.

Deigham (1971) used 1 022 students and 44 teachers in grades three, five, and six to investigate the relationship between teacher and student attitudes and found no significant relationship between the two. He did, however, find a small relationship between the attitude of the teacher toward arithmetic and the students' achievement in arithmetic.

Summary

Since attitudes are first formed at the elementary level, the attitudes of both the elementary teachers and students are worthy of consideration. While teachers have developed a set of attitudes through a long chain of experiences, students are still in the process of building theirs, and must be given the proper construction blocks with which to erect a set of positive attitudes toward mathematics.

A teacher often reflects his attitudes toward a subject as he teaches it. A teacher who feels insecure in mathematics, for whom mathematics is mostly rote manipulation, with little understanding, transmits these feelings to his students.

It is generally found that the attitudes of elementary teachers toward mathematics are less favourable than those of junior high and senior high teachers. This may be in part due to the specialization of most junior and senior high teachers.

SUMMARY

In this chapter a review of the literature relavant to the study has been presented. Piaget, and others doing replications of his work, have indicated the importance of providing appropriate experiences for the child to coincide with his stage of mental development. Since most elementary school children would be at the concrete operational stage of development, experiences such as manipulation of geometric shaped objects can be very important at this level. This reinforces the need for an activity based geometry curriculum for the elementary schools.

The review of literature on geometry clearly indicated that there are many aspects of geometry that can be learned by elementary school children. The need to provide manipulative experiences, especially at the lower elementary level, was reported as being important. Elementary school children possess a variety of geometric skills, and can develop them if given the opportunity to do so. No one method of instruction was found to be superior to all others for teaching all aspects of geometry. There were many options available, and the one to be used would depend upon the type of activity or lesson to be presented. There were some questions raised about the competency of elementary school teachers in geometry. The unfamiliarity of teachers with geometric terms and lack of skills might cause elementary school teachers to fear somewhat the geometric topics.

The overall attitude of elementary school children toward mathematics was reported as being highly positive. The attitude of elementary school teachers was found to be neutral at worst. This is an important factor, when we consider the effect teacher attitudes may have on the attitudes and achievement of the children they teach.

CHAPTER III

EXPERIMENTAL DESIGN OF THE STUDY

The two main purposes of this study were, to determine the amount of time spent on teaching geometry in the elementary schools, and to investigate its relationship to teacher attitudes toward geometry. In this chapter the experimental design of the study, including the population and samples and the instrumentation used are described. The questions which the study attempted to answer and the methods used to analyse the data are also stated.

DESIGN OF THE STUDY

This study consisted of (a) the analysis of elementary teachers' attitudes toward geometry as measured by a 45-item, Thurstone-type scale, developed by Silance and Remmers (1934), (b) the determination of the number of weeks elementary teachers spent teaching geometry for the school year 1978-1979, (c) comparative analysis of urban and rural teachers in terms of attitude and time, (d) teachers' personal experience with certain areas of geometry and their preparation to teach them, (e) method of instruction, and (f) teacher familiarity with geometric aids.

The research design was basically a survey type (Kerlinger, 1973), looking at a large population by selecting randomly and studying a small sample chosen from the population. The subjects had developed their attitudes prior to the study, and were categorized urban or rural on the basis of where in Newfoundland they taught, a criteria which they had also already met before the commencement of this research.

POPULATION AND SAMPLE

POPULATION

The population studied consisted of all elementary school teachers in the province of Newfoundland for the school year 1978-1979 who met the following conditions:

(a) taught mathematics

(b) taught at least one of grades 3, 4, 5, or 6.

SAMPLE

The sample was stratified into two categories, urban and rural, based on the size of the communities in terms of population. Only selected urban and rural areas of Newfoundland were chosen because of time and transportation restrictions. It should be noted that the areas to be studied were selected, and then the schools and teachers were chosen randomly from this selection. In terms of urban areas, St. John's, Gander, Lewisporte, Bishop Falls, Grand Falls, Deer Lake, and Corner Brook were selected. A list was then compiled of all the elementary schools in these major centers, and twenty were randomly selected. Of those twenty schools selected, eighteen were visited by the investigator. Two had to be omitted because of time conflicts due to unexpected delays in travelling.

Upon contacting the principal of each school, a list was made of all the teachers that were part of the population. From this list three teachers were selected at random from each school, and thus became part of the sample. Of the 54 teachers selected, 53 completed the questionnaire. One teacher requested permission to take home the questionnaire and return it by mail. It was never received.

A similar procedure was used for selection of the rural sample. The areas selected included the Burin Peninsula, the Bay d'Espoir area, Burgeo and Ramea area, Bonavista, Trinity and area, Hermitage, Fortune Bay, and the Placentia area. Twenty-five schools were randomly selected from those areas, and twenty-three were visited. A total of 51 questionnaires were completed. Two schools were omitted because of difficulty in travel arrangements and two teachers did not complete the questionnaire. One teacher felt that much of the material did not apply to the elementary level, and the other could not find the time to complete it. The selection of teachers in the rural areas was sometimes limited by one teacher per grade, or sometimes one teacher for all four grades.

INSTRUMENTATION

DESCRIPTION OF THE INSTRUMENTS

In this study two instruments were used to collect the required data. The major instrument (Appendix I) will be referred to as instrument A, and a second instrument, instrument B.

INSTRUMENT A consisted of four sections. The first section was an information sheet giving the location, background relative to mathematics, education, experience, and present teaching level of the teacher, as well as the type of timetable cycle being used and number of mathematics periods per week. This information was requested to provide the investigator with a more accurate description of the teacher, both geographically and academically, in addition to providing information about the structure of the school.

The second section consisted of a 45-item attitude questionnaire developed by Silance and Remmers (1934) to measure attitude toward any school subject. In the questionnaire, school subject was replaced by geometry. The teachers were required to mark (✓) if they agreed with the statements, (X) if they disagreed, or (?) if they were undecided. Each item had been assigned a value by the designers of the attitude questionnaire in terms of attitude measure ranging from 0.6 (I hate geometry), to 10.3 (no matter what happens, geometry always comes first). The individual's score was then taken to be the mean of the scale values of the items endorsed by that person.

The third section dealt with (a) the opinions of teachers relative to the percentage of time they feel should be devoted to geometry at primary, elementary, and junior high levels of the curriculum, (b) the percentage of time spent on geometry at the elementary level that should be activity oriented, (c) a breakdown of geometry into seven main areas where teachers were asked to indicate their experience with and preparation for these topics, and (d) a list of materials available to teachers to aid in the teaching of geometry to which the teachers were asked to indicate their familiarity.

The fourth section gave a listing of 15 topics found in the ISM mathematics program for elementary schools. Teachers were asked to rank these (1-15) in order of importance as they perceived them for an elementary mathematics program.

INSTRUMENT B (Appendix II) consisted of an analysis of each chapter dealing with geometry in the ISM program for grades 3, 4, 5, and 6, into topics as they were presented in the text. Teachers were asked which chapters they had completed or intended to complete. If they indicated some of the geometry chapters, they were then asked which topics they had covered in these chapters and how much time they had spent on each topic. From this was determined the total amount of time teachers spent teaching geometry. To simply ask each individual teacher how many weeks they had spent teaching geometry was felt to be an unreliable approach to answering the question since the time span involved was a year.

VALIDITY AND RELIABILITY

In spite of the disadvantages of the questionnaire method of research, it has the advantage that a large amount of data can be gathered from widely scattered respondents with a minimum of effort and expense, in a fairly valid and reliable manner. In the instruments used in this study two types of items were used: those requiring the respondent to make judgments, express opinions, or give attitudinal responses to some statements, and those that require the respondent to give purely factual information. Sections I and III of the major instrument A and all of instrument B require only factual information. The collection and analysis of the data from these questions was tabulated in a purely descriptive manner.

Part II of the major instrument, the attitude questionnaire was constructed from a very large sample of several thousand respondents consisting of high school students and college undergraduates. The authors reported reliabilities ranging from 0.81 to 0.90 using both high school and college students and using different school subjects as attitudinal referents. Ferguson (1952) cites the reliability for mathematics (N = 579) to be 0.74. While there are shorter forms available, the longer (45-item) form is more reliable. Bolton (1938) validated the scale for mathematics in terms of content validity.

Section IV of the major instrument was developed by the investigator. It was then pilot studied with two groups of 10 teachers each for reliability of responses. There was a two-week period between the time the instrument was first given and the second time it was administered. This was done in the fall of 1977 and reliabilities of 0.86 and 0.82 were found.

The whole instrument was pilot studied in July, 1978 with a group of elementary teachers at Memorial University. This resulted in changes in section III of the instrument involving breaking down the topics relevant to geometry, and omitting a section at the end where the respondent was required to give the number of weeks spent teaching geometry during the past year. In its place, instrument B was developed. This instrument was not dependent upon one's judgment of time but recorded factual information on time spent teaching geometry.

LIMITATIONS OF THE STUDY

Because of the design of the study, several limitations were unavoidable. These limitations included the following:

(1) Placing the ranking of topics in mathematics after the attitude section of the questionnaire might cause the ranking to be

influenced by the questionnaire itself.

(2) The presence of the interviewer might have temporarily lifted the respondent out of his natural social context.

NULL HYPOTHESES AND STATEMENT OF ANALYSES USED

This study was concerned with nine questions together with their relation to elementary school teachers' attitudes toward geometry and the amount of time these teachers spend teaching geometry. These questions, along with the corresponding statistical analysis used to test the hypotheses, or describe the data collected, are given below.

QUESTION 1

What are the attitudes of elementary school teachers toward geometry?

This question was answered by administering a 45-item attitude questionnaire to the 104 teachers in the sample. This questionnaire was designed to measure attitude toward any school subject. School subject in the original questionnaire was replaced by geometry in the form used in the study. Each item was assigned a scale value, based on the nature of the item in terms of the degree of relative strength toward the subject. The teachers could respond to each item in one of three ways: agree, disagree, or undecided. Each individual teacher's score was calculated to be the mean of the scale values of the items agreed with by the person.

To determine the overall attitude of elementary school teachers toward geometry, the mean of the 104 teachers' scores was calculated. Attitude was then expressed in terms of the statement associated with the scale value nearest the mean. For example, if the overall mean was

5.5, then the corresponding attitude statement would be "I haven't any definite like or dislike for geometry."

QUESTION 2

Are there any differences between the attitude of elementary school teachers in rural and urban areas of Newfoundland toward geometry?

The sample in this study was stratified into two categories, urban and rural, based on the population of the communities in which the teachers worked.

Hypothesis 1: There is no significant difference in the attitude of elementary teachers in rural and urban areas of Newfoundland toward geometry.

This hypothesis was tested by conducting a t-test (Ferguson, 1971) on the difference of the mean attitude scores for urban and rural teachers in the sample.

QUESTION 3

How many weeks do elementary school teachers spend per year teaching geometry?

To answer this question a special instrument, instrument B (Appendix II), was developed.

Prior to the use of the instrument, each teacher was asked to indicate from the table of contents in their mathematics teachers' guide the chapters they had covered either in part or in full. They were then asked what they intended to cover in the time remaining in the year. If they indicated that no geometry topics had been done, and they did not intend to do any, they were given a score of zero. If they indicated certain geometry topics had been done, then the instrument was used.

The instrument consisted of an analysis of the chapters on geometry in grades 3, 4, 5, and 6 into topics by chapter. The appropriate grade level was chosen, depending upon what grade the teacher was teaching, and the chapter or chapters the teacher had indicated as being covered or intending to cover were selected. The teacher was then asked to indicate which topics were covered in the chapter(s) and how much time, usually in terms of class periods, had been spent on each topic. From this information the total number of weeks spent teaching geometry was calculated for each teacher. The mean of these scores was then found.

QUESTION 4

Are there any differences between the number of weeks elementary school teachers in rural and urban areas of Newfoundland spend teaching geometry?

In general, schools in the urban areas of Newfoundland are usually larger than those found in the rural areas. In many rural areas of Newfoundland it is not uncommon to have more than one grade per classroom, a situation that rarely, if ever, exists in urban centers in the province. This might or might not have influenced the number of weeks urban and rural teachers spent teaching geometry.

Hypothesis 2: There is no significant difference in the number of weeks elementary school teachers in rural and urban areas of Newfoundland spend teaching geometry.

A t-test was used to test the significance of this difference.

QUESTION 5

Does a relationship exist between elementary school teachers' attitudes toward geometry and the number of weeks they spend teaching geometry?

Both a measure of attitude and a measure of the number of weeks spent teaching geometry were available from this study. A Pearson-product moment correlation coefficient was calculated between these two variables to test the following hypothesis.

> Hypothesis 3: There is no significant relationship between elementary school teachers' attitude toward geometry and the number of weeks they spend teaching geometry.

Also available was a second measure of attitude. The teachers were asked to rank geometry on a scale of 1-15 with other topics found in the elementary school mathematics curriculum. This was considered to be a reflection of their attitude toward geometry. An histogram was constructed to present the data on the ranking of geometry by the teachers.

QUESTION 6

What personal experience do elementary school teachers possess with regard to certain areas of geometry?

This question was answered using the data collected from instrument A on teacher experience. Tables were constructed to show the cumulative frequency of responses made by the teachers to each individual item. This data was presented in tabular form. The major areas investigated were motion geometry, plane geometry, solid geometry and coordinate geometry.

QUESTION 7

How well prepared are elementary school teachers to teach certain areas of geometry?

If teachers do not feel prepared to teach a topic that is part of a given curriculum, then there is reason for concern, if that topic is part of the required curriculum. The question of teacher preparation was answered in this study by preparing a table presenting the responses of the teachers to the areas of geometry referred to in question 6. The responses range from fully prepared to not prepared at all.

QUESTION 8

What percentage of the time spent teaching geometry do elementary teachers feel should be activity oriented?

There exists an abundance of research indicating that a child's experience with geometry at the elementary level should consist of "hands-on" experiences. Since much of the work at the elementary level involves laboratory type exercises, where the manipulation of objects is very important, one might expect a large percentage of the time spent doing geometry at this level to be activity oriented. The data from this study relevant to this question was organized into a table indicating what percent of the time spent teaching geometry at the elementary level teachers felt should be activity oriented. Five intervals were used ranging from 0-20% of the time to 80-100% of the time.

QUESTION 9

How familiar are elementary school teachers with the materials available to aid in the teaching of geometry?

While there is considerable support for the use of manipulative aids when teaching geometric concepts, there is some question concerning how familiar elementary teachers are with these aids. This study listed seven such aids and asked teachers to indicate how familiar they were with them. A table was used to compile the data collected from this question.

SUMMARY

No statistical hypotheses were constructed for questions 1, 3, 6, 7, 8, and 9. These questions were answered using descriptive statistics. In this chapter the experiemental design of the study has been presented, indicating where the data to be used in Chapter IV was obtained. The data collected in this study will be presented in the following chapter and discussed in Chapter V.

CHAPTER IV

THE RESULTS OF THE STUDY

The main purpose of the study was to investigate the relationship between the attitudes of elementary school teachers toward geometry and the amount of time they spent teaching geometry. In this chapter the results of the analysis of the data relating to the nine main questions are presented.

The population in this study consisted of all elementary school teachers in the province of Newfoundland for the school year 1978-1979 who taught mathematics in at least one of grades 3, 4, 5, or 6. To present a more informative picture of the population, data was collected relative to their academic background and teaching experience. This data is presented prior to the data relating to the nine questions under consideration.

TABLE 1

TEACHER QUALIFICATIONS

	N	Mean Teaching Experience	Mean Number University Courses	Mathematics Majors
Rural	51	9.03 y	45.43	2
Urban	53	14.55 y	49.51	1
Total	104	11.84 y	47.51	3

Teacher qualification is often defined in terms of teaching experience, number of university courses completed, and number of courses completed in one's area of specialization. Table 1 gives a clear indication that a difference exists between teachers in urban and rural areas of Newfoundland in at least one of these conditions, namely teaching experience. There is very little difference in the number of university courses completed by the two groups. Mathematics does not appear to be a very popular area of specialization among elementary school teachers with less than 3% of the teachers sampled reporting mathematics as a major. The number of mathematics courses other than 1150 (a course for primary and elementary teachers emphasizing the mathematical systems and topics in finite mathematics) and 1151 (a course in geometry for primary and elementary teachers) completed by the 104 teachers sampled, along with the respective percentage, are listed in Table II.

TABLE II

MATHEMATICS COURSES COMPLETED

	Number of Mathematics Courses Completed						
	0	1-2	3-4	5-6	7-8	over 8	unknown
Number of Teachers	69	20	6	3	0	5	1
Percentage	66.3	19.2	5.7	2.8	0.0	4.8	0.9

A major objective in the preparation of elementary school mathematics teachers is the development in these prospective teachers of certain attitudes toward and beliefs about mathematics and how it is learned. This is done by requiring all elementary teachers to do at least two methods courses in mathematics education and Mathematics 1150 and 1151. There are four methods courses available to elementary teachers: Education 2340, Education 2341, Education 3440, and Education 3441. A brief description of these courses is given below:

Ed. 2340 and Ed. 2341 -- Directing learning experiences in mathematics for children in primary and lower elementary grades (K-6)

Ed. 3440 and Ed. 3441 -- Mathematics programs and teaching methods for the upper elementary grades (6-8)

Prior to 1966, Education 125 was the only methods course offered in mathematics education for primary and elementary teachers. In 1966-1967 two new courses--Education 2310 for primary teachers and 2320 for elementary teachers--were introduced, and what was once Education 125 now became Mathematics 115. In 1972, Education 2310 and 2320 were replaced by Education 2340 and 2341. At the same time Ed. 3440 and Ed. 3441 were introduced. What was once Mathematics 115 became Mathematics 1150 and 1151. The number of teachers in the sample who have completed each of the above courses are given in Table III.

Summary. Gearhart (1975) and others have shown the importance of teacher training and experience when introducing new topics in mathematics. The teachers in this study, while lacking in academic qualifications in mathematics, certainly are qualified in teaching experience and overall university courses. One factor that might have influenced the attitude of the teachers may very well have been how recently they completed their methods courses in mathematics education. However, this factor was not examined in this study.

TABLE III

REQUIRED MATHEMATICS AND MATHEMATICS EDUCATION COURSES COMPLETED

Course Number	No. of Teachers Having Completed the Course
Ed. 2340	30
Ed. 2341	17
*Ed. 2310	6
*Ed. 2320	15
Ed. 3440	5
Ed. 3441	3
Math 1150	49
Math 1151	45
Ed. 125	45

*Teachers having completed Ed. 2310 or Ed. 2320 were not permitted to do either Ed. 2340 or Ed. 2341.

QUESTION 1

What are the attitudes of elementary school teachers toward geometry?

The answer to this question was sought to indicate the nature of attitudes toward geometry of elementary school teachers in the province of Newfoundland. If the mean score on the attitude questionnaire was high, 8.5 or above, it indicated a good attitude toward geometry. If it was found to be 3.6 or below, then a poor attitude was interpreted. If the mean score fell somewhere between 3.6 and 8.5, several statements associated with the scale values nearest the mean were used to express the attitude. To understand more fully the position of any attitude statement, reference should be made to Appendix III which lists all the attitude statements and their respective scale values.

In this study a mean score of 7.46 was found, with a standard deviation of 1.17 for the 104 cases in the sample. The two statements nearest the reported mean were 7.6 (geometry is not receiving its due in public high school), and 7.3 (geometry saves time). Since a standard deviation of 1.17 was found, approximately 68 percent of the mean attitude scores from the 104 teachers sampled would fall between scores of 8.63 (geometry is a universal subject), and 6.29 (I don't believe geometry will do anybody any harm). This indicates a relatively high positive attitude expressed by the sample. Further interpretations of these findings are found in Chapter V of this study.

A second measure of attitude used in this study was the ranking of geometry with fourteen other mathematical topics taught at each grade level (see Appendix I). While this was a more indirect measure of attitude, the relative position of importance given geometry by the teachers was a reflection of their attitude toward geometry. In Figure I the results of these rankings are graphed.

It is apparent from Figure I that elementary school teachers do not rank geometry among their high priorities for an elementary mathematics curriculum. If we take (7-9) to be the mean interval, we see that 17 out of 104, or approximately 15%, of the teachers ranked geometry above the mean interval, while 48 out of 104, or approximately 46%, ranked it below the mean interval. This tended to indicate a more negative attitude than was reported by the questionnaire. However, we must

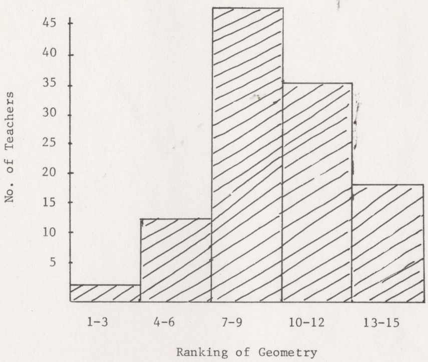

FIGURE I

RANKING OF GEOMETRY WITH 14 OTHER MATHEMATICAL TOPICS

remember that there were more factors than attitude that influenced how a person ranked geometry. These factors will be discussed in Chapter V of this study.

Teachers in this study were asked to rank the fifteen topics in elementary school mathematics in terms of importance as they saw them for an elementary mathematics curriculum. While they were directed to consider an elementary curriculum (grades 3-6) rather than just the grade they taught, there is no doubt that their opinions were biased by the grade they were teaching. The rankings by grade for the 104 teachers involved in the study are given in Table IV.

TABLE IV

PERCENTAGE OF TEACHERS AT EACH GRADE LEVEL THAT RANK GEOMETRY IN EACH OF THE FIVE INTERVALS

Grade	N	Ranking				
		(1-3)	(4-6)	(7-9)	(10-12)	(13-15)
3	20	5.0	10.0	35.0	35.0	15.0
4	27	0.0	14.8	44.4	25.9	14.8
5	31	0.0	16.1	38.7	29.0	16.1
6	26	0.0	19.2	34.6	34.6	11.5
Total	104	1	16	40	32	15
Percentage		(0.9)	(15.3)	(38.4)	(30.7)	(14.4)

One might expect the rankings to be more favourable toward geometry or the grade interval. In this study this result did not occur for each interval. The only interval where it did occur was (4-6). This might have indicated a slight improvement in rankings toward the upper end of the scale as the grade levels increased.

QUESTION 2

Are there any differences between the attitudes of elementary school teachers in rural and urban areas of Newfoundland toward geometry?

Hypothesis 1 was tested to indicate whether there was a difference between the mean attitude score for elementary school teachers in rural areas of Newfoundland toward geometry and the mean attitude score for elementary school teachers in urban areas of Newfoundland toward geometry. If there was a significant difference between the two groups, then further investigation would be needed to determine the cause of such a difference.

Hypothesis 1: There is no significant difference in attitude of elementary school teachers in rural and urban areas of Newfoundland toward geometry.

The above hypothesis was tested using a t-test for independent samples. The results are summarized in Table V below:

TABLE V

RESULTS OF t-TEST ON ATTITUDES BETWEEN RURAL AND URBAN TEACHERS

Group	N	Mean	Std. Dev.	t Value	2-Tail Prob.
Urban	53	7.65	0.78	1.69	0.095
Rural	51	7.27	1.44		

In order to be significant at the .05 level of significance for 102 degrees of freedom, a t-value of approximately 1.99 was required. Since the t-value found was less than the required value, no adequate grounds exist for rejecting the null hypothesis. Hence no justification was found for drawing the inference from the data collected that a significant difference in attitude existed between the two populations.

A second measure of attitude, the ranking of geometry with fourteen other mathematical topics, produced very similar results. These findings are diagrammed in Figure II.

A negative skewness existed for both samples. The rural sample reported a skewness of -2.1 and the urban sample -1.8. This does not

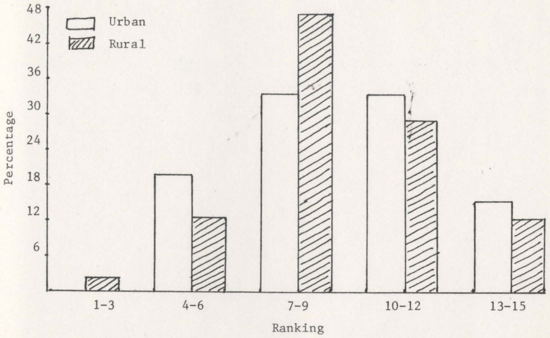

FIGURE II

PERCENTAGE OF TEACHERS RANKING GEOMETRY AT EACH OF FIVE INTERVALS FOR RURAL AND URBAN SAMPLES

mean that a negative attitude was indicated, but that other mathematical topics were seen as being more important than geometry.

QUESTION 3

How many weeks do elementary school teachers spend per year teaching geometry?

The number of weeks recommended by the authors of the ISM mathematics program for geometry at the elementary school level is approximately seven at each grade level. The answer to this question was sought to indicate how many weeks elementary school teachers in the province of Newfoundland spent teaching geometry for the school year 1978-1979.

For the 104 teachers sampled a mean of 2.53 was found with a standard deviation of 2.13. This data indicates that approximately 68 percent of the teachers involved in the study spent between 4.6 weeks and 0.4 weeks teaching geometry. This is far below the amount of time recommended by the authors of the program. Further interpretations of this data will be discussed in Chapter V of this study.

There were many factors influencing the number of weeks spent teaching geometry by the teachers in the sample. These are discussed in Chapter V. In addition to reporting the number of weeks spent teaching geometry, these same teachers were asked their opinions on what percentage of time spent on mathematics they felt should be devoted to geometry. The results of this question are presented in Table VI.

TABLE VI

PERCENTAGE OF TIME SPENT ON MATHEMATICS THAT SHOULD BE DEVOTED TO GEOMETRY

Level	Time				
	0-10%	10-20%	20-30%	30-40%	40-50%
Primary	52	38	9	4	1
Elementary	20	51	29	4	0
Junior High	3	28	49	23	1

All teachers in the sample were asked to indicate how much time they felt should be spent on geometry at all three levels. This table indicates that elementary school mathematics teachers tend to see geometry as being more important as the child progresses through different levels of schooling. There is a difference in the opinion of elementary school teachers on how much time should be spent teaching geometry and the actual amount spent. If the lower limit of the interval, 10-20%, were taken to represent the 51 teachers at the elementary level, this would indicate 3.6 weeks as being the desired amount of time to spend on geometry. The range for this interval is 3.6 to 7.2 weeks. This is much higher than the reported amount of time now being spent on geometry as stated earlier.

QUESTION 4

Are there any differences between the number of weeks elementary school teachers in rural and urban areas of Newfoundland spend teaching geometry?

Hypothesis 2 was tested to indicate whether there was a difference between the number of weeks elementary school teachers in rural and urban areas of Newfoundland spend teaching geometry. If a significant difference was found, then further investigation would be required to determine why such a difference occurred.

Hypothesis 2: There is no significant difference between the number of weeks elementary school teachers in rural and urban areas of Newfoundland spend teaching geometry.

The above hypothesis was tested using a t-test of significance for the two independent samples. The results are recorded in Table VII.

The level of significance required for this test was the .05 level. In order to be significant at this level with 102 degrees of freedom a t-value of approximately 1.99 was required. The reported t-value of 0.36 is far below the required value. Therefore, no adequate

TABLE VII

RESULTS OF t-TEST ON WEEKS SPENT TEACHING GEOMETRY BY TEACHERS IN RURAL AREAS VERSUS TEACHERS IN URBAN AREAS

Group	N	Mean	Std. Dev.	t-Value	2-Tail Prob.
Urban	53	2.60	2.31	0.36	0.717
Rural	51	2.45	1.95		

grounds exist for the rejection of the hypothesis 2, and because of this, no justification was found for drawing the inference from the data collected that a significant difference in the number of weeks spent teaching geometry existed between the two populations.

A further measure of time was found when teachers reported what percentage of time allocated to mathematics they felt should be spent on geometry. This was done for both the urban and rural areas. The results of these findings are diagrammed in Figure III.

The similarity of the interval towers for each group further points out the insignificance of any difference that might have been found between the percentage of time elementary school teachers felt should be spent teaching geometry.

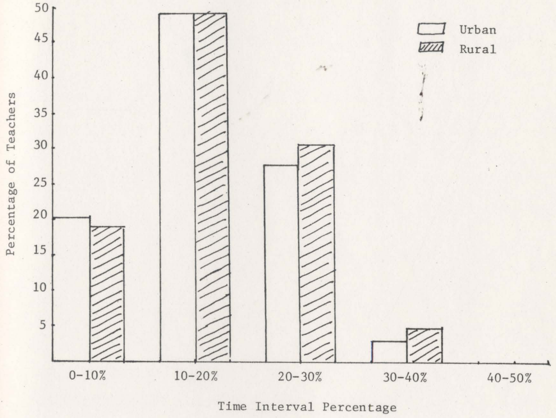

FIGURE III

PERCENTAGE OF TIME SPENT ON MATHEMATICS THAT SHOULD BE DEVOTED TO GEOMETRY

QUESTION 5

Does a relationship exist between elementary school teachers' attitude toward geometry and the number of weeks they spend teaching geometry?

The main problem under consideration in this study was the relationship between the attitudes of elementary school teachers toward geometry and the amount of time spent teaching geometry. This answer to this question was sought to indicate if such a relationship did exist.

Hypothesis 3: There is no significant relationship between elementary school teachers' attitudes toward geometry and the number of weeks they spend teaching geometry.

The above hypothesis was tested using a Pearson product moment correlation coefficient. The correlation coefficient found was 0.26. This indicated that a low positive relationship existed between teacher attitude and time. The following formula $t = \sqrt{\frac{N-2}{1-r^2}}$ where df = N-2 was used to test the significance of this correlation. It was found to be significant at the .01 level of significance.

There are many possible reasons why this result occurred. These reasons are discussed in Chapter V of this study.

QUESTION 6

What experience do elementary school teachers possess with regard to certain areas of geometry?

There is much research evidence that indicates one's unwillingness to introduce new topics in mathematics is often due to lack of experience with this topic. To answer this question, geometry was broken down into a number of topics, and teachers were asked to indicate their experience with each topic individually. The results are listed in Table VIII. This table gives the frequency of responses reported by the teachers.

TABLE VIII

TEACHER EXPERIENCE WITH CERTAIN TOPICS IN GEOMETRY

	Experience*					
Topic	1	2	3	4	5	6
Motion Geometry	9	7	7	8	70	3
MEASUREMENT						
i Non standard units	69	13	4	4	13	1
ii Standard units	85	9	6	0	4	0
iii Exactness	75	13	4	1	10	1
iv Length	94	4	4	1	1	0
v Perimeter	90	7	4	1	2	0
vi Area	94	4	2	2	2	0
vii Volume	89	7	3	1	4	0
viii Angles	88	6	3	3	3	1
PLANE GEOMETRY						
i Constructions						
(a) compass and straight edge	66	26	4	3	4	1
(b) mira	12	10	2	5	75	0
(c) paper folding	74	20	6	1	3	0
ii Similarity	74	20	6	1	3	0
iii Congruence	73	23	4	1	3	0
iv Parallel lines and related angles	80	15	3	2	4	0
v Symmetry	63	26	5	3	6	1
vi Open and closed curves	66	21	9	2	6	0
vii Polygons	67	24	5	5	2	1
viii Pythagorean theorem	36	43	6	7	10	2
SOLID GEOMETRY						
i Space figures	34	24	8	8	29	1
ii Relation of lines in space	32	25	9	7	29	2
COORDINATE GEOMETRY	35	24	9	7	29	0
SYMBOLIC LOGIC	10	17	9	7	59	2
GEOMETRY THROUGH REAL LIFE SITUATIONS	51	11	7	9	26	0

*

1 - Have taught

2 - Have studied in a course

3 - Have seen materials

4 - Have read articles or heard talks

5 - Nothing at all

6 - Some combination of 2, 3, 4, and 5

QUESTION 7

<u>How well prepared are elementary school teachers to teach certain areas of geometry</u>?

In any field of education a teacher who is required to teach some topic is expected to prepare fully for the job. Unfortunately, being fully preapred means different things to different people. In this study, fully prepared meant that no form of upgrading was needed to teach the topic. The data on teacher preparation is given in Table IX. The relationship between these results and the ones in Table VIII is quite apparent.

QUESTION 8

<u>What percentage of time spent on geometry do elementary school teachers feel should be activity oriented</u>?

Since the emphasis on informal geometry in the elementary grades, much discussion has taken place on the type of geometry program best suited for elementary school students. One factor that has been established is that regardless of the type of content used, the format should be activity oriented as much as possible. The opinions of the teachers in this study regarding the percentage of time spent on geometry in the elementary grades that should be activity oriented is given in Table X. These results are discussed in Chapter V of this study.

TABLE IX

TEACHER PREPARATION FOR TEACHING VARIOUS ASPECTS OF GEOMETRY

	Teacher Preparation*				
Topic	1	2	3	4	5
Motion Geometry	6	21	16	5	56
MEASUREMENT					
i Non standard units	58	19	16	3	8
ii Standard units	65	23	9	3	4
iii Exactness	62	25	9	5	3
iv Length	77	15	5	2	5
v Perimeter	78	14	3	4	5
vi Area	78	13	5	3	5
vii Volume	69	23	5	4	3
viii Angles	68	23	6	4	3
PLANE GEOMETRY					
i Constructions					
(a) compass and straight edge	58	24	11	5	6
(b) mira	13	19	16	5	51
(c) paper folding	44	28	15	6	11
ii Similarity	56	23	12	5	8
iii Congruence	57	26	10	5	6
iv Parallel lines and related angles	58	24	15	3	4
v Symmetry	70	14	10	1	9
vi Open and closed curves	68	23	9	2	2
vii Polygons	55	25	17	2	5
viii Pythagorean theorem	42	26	24	0	12
SOLID GEOMETRY					
i Space figures	23	25	23	10	23
ii Relation of lines in space	24	27	23	7	23
COORDINATE GEOMETRY	35	26	18	8	17
SYMBOLIC LOGIC	14	20	23	8	37
GEOMETRY THROUGH REAL LIFE SITUATIONS	31	28	19	9	17

*
1 - Fully prepared

2 - Need some personal study

3 - Need a course or a workshop

4 - Need more than a course or two

5 - Not prepared at all

TABLE X

PERCENTAGE OF TIME SPENT ON GEOMETRY IN THE ELEMENTARY GRADES THAT SHOULD BE ACTIVITY ORIENTED

Percentage	0-20	20-40	40-60	60-80	80-100
No. of Teachers	20	31	15	20	18

QUESTION 9

How familiar are elementary school teachers with the materials available to and in the teaching of geometry?

To do many of the activities set out in the ISM mathematics program requires teachers to make use of various manipulative aids such as geoboards and tangrams. There are many such aids available to help teachers in their instruction of elementary school geometry. This study considered seven such aids and asked the teachers to indicate their familiarity with them. The results of their opinions are shown in Table XI. These results are discussed in Chapter V of this study.

SUMMARY

Chapter IV has presented the data collected in the study relative to the nine questions given in Chapter I. Very little attempt has been made to discuss these results at this point. The discussion of the results and implications are given in the following chapter. Also discussed in Chapter V are the recommendations for further study in the area of elementary school geometry.

TABLE XI

TEACHER FAMILIARITY WITH GEOMETRIC AIDS

Geometric Aid	Presently using or have used	Like to use but not available	Available but do not use	Not available and would not use if they were	Not familiar with
Geoboard	24	22	8	3	47
Mira	0	7	3	2	92
Attribute Blocks	13	19	5	4	62
Pattern Blocks	14	20	6	3	61
Geo-Strips/Straws	26	14	13	0	51
Tangrams	11	14	3	1	75
Pentominoes	2	8	2	3	89

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Considerable emphasis has been placed on the position of geometry in our elementary schools over the past few years. While it is still not clear exactly what should be done, and when, there is much agreement on the position that geometry has to play a more important role in the elementary school mathematics curriculum in the future than it has in the past. This position was further emphasized at the Annual General Meeting of the Mathematics Special Interest Council of the NTA for 1978-1979.

This study attempted to determine how much time was being spent on geometry by elementary school teachers. Also investigated was the relationship between elementary school teachers' attitudes toward geometry and the amount of time they spend teaching the subject. Consideration was given to any differences that might exist between teachers in rural and urban areas of the province. Other considerations in the study include teacher experience with certain topics in geometry and their preparation to teach them, method of instruction, and familiarity with manipulative aids available to assist in teaching geometry.

Teachers selected to take part in the study were asked if they were willing to participate, and their participation, while important to the study, was strictly voluntary.

THE STUDY

The population under investigation in this study was elementary school teachers in the province of Newfoundland for the school year 1978-1979 who taught mathematics in at least one of grades 3, 4, 5, or 6. A sample was chosen from this population, and the two major areas of concern, attitudes and time, were investigated. The sample was stratified into rural and urban areas of the province.

The research technique used to carry out the study was a survey questionnaire. The questionnaire was found to be both reliable and valid for the study. Prior to the commencement of the research, a pilot study was conducted on a similar but smaller sample. The questionnaires used in the study were delivered personally to the teachers involved, and in all but a few cases were collected in the same manner.

Each teacher in the sample was asked to complete a questionnaire (Appendix I). This instrument revealed information about the teachers' qualifications, attitude toward geometry, knowledge of geometric aids available, experience with certain areas of geometry, and preparation to teach these same areas, opinions on the percentage of time spent on mathematics that should be devoted to geometry at one level below and one level above the elementary level in addition to the elementary level, and opinions on the role activities should play in the instruction of elementary school geometry.

After this questionnaire was completed, instrument B (Appendix II) was used to determine the amount of time the teachers spent teaching geometry. This instrument was not given to the teachers to complete. The researcher used this instrument to record what exactly had been done in the area of geometry, and how much time had been spent doing it.

While one of the major considerations in this study was the relationship between elementary school teachers' attitudes toward geometry and the amount of time they spend teaching geometry, several other questions were also investigated. The results of these questions, along with the above, are discussed in detail in the following section of this chapter.

DISCUSSION OF RESULTS

The results of this study were presented in detail in the previous chapter within the framework of the questions stated in Chapter I. In this chapter the results as they relate to the study are discussed. Before discussing the results, some comments will be made with respect to the design of the study and the procedures used to collect the data as they influenced the results.

To provide a more reliable source of data than would be obtained from mailing the questionnaires, the researcher conducted the interviews personally. This method of data collection may have influenced the way the teachers responded to the questions they were presented with as discussed earlier in the limitations. Therefore, the attitude score obtained from the teachers might be somewhat inflated.

The justification offered by the teachers for not having done the geometry chapters may have been given because they had just completed the questionnaire on geometry. Many teachers were very defensive about the fact that they had not covered the topics relating to geometry. Hence, the design of the study, as mentioned in the limitations, may have influenced the teachers indication of time spent on geometry. However, it was felt that the majority of teachers were very accurate in their estimation of time spent teaching geometry.

The attitude of elementary school teachers toward geometry in this study was found to be a relatively high positive one. This is somewhat in line with the findings of E. G. Begle (1979) in his survey of empirical literature on mathematics. Begle reported that "elementary school teachers seem to have attitudes toward mathematics which are neutral at worst" (p. 28). While these findings are contrary to commonly accepted beliefs about teachers' attitudes toward geometry, especially at the elementary level, there are several reasons why these results may have occurred.

Geometry has been established as part of the core mathematics program for the elementary schools, and consequently teachers are expected to teach it. Realizing this, teachers are somewhat reluctant to express a negative attitude towards geometry. Less than five percent of the teachers in the sample reported a poor attitude, expressing dislike for the subject as indicated by their mean attitudinal score. Secondly, teachers have a tendency to like or dislike a subject based on how well their students receive the material. Geometry at the elementary level has been reported, almost without exception, as being enjoyed by the students. In addition to the teachers' attitudes being transmitted to the students, to some extent the enthusiasm of the students for the subject may have influenced the teachers' responses to the attitude questions.

A second measure of attitude used in the study did not produce as favourable results. When teachers were asked to rank geometry with fourteen other mathematical topics, there was a tendency to rank geometry in the middle at the best. This could be interpreted to indicate a less positive attitude toward geometry. However, there were several factors influencing the ranking of these topics.

It has been an accepted tradition in the elementary schools that emphasis in mathematics should be placed on computation. Hence, the first priorities, in most cases, were topics associated with computation. These included whole number computation, decimals and fractions. Crucial to the understanding of computation, are the areas of number theory, set theory, and place value. Thus, when we consider that measurement was also given as a separate topic, it is not surprising that geometry was seldom ranked higher than eighth or ninth.

Another factor that may have influenced the ranking of geometry as indicated by the data was the tendency of the teacher doing the ranking to think more in terms of the grade they were currently teaching than the elementary curriculum as a whole. This was indicated by the slight improvement in rankings of geometry toward the upper end of the scale as the grade levels increased.

These results are encouraging to anyone who believes that geometry has its place in the elementary school curriculum. If one considers a poor teacher attitude as being an obstacle to introducing new materials, then in the case of geometry this obstacle may not exist. Unfortunately there are many factors other than attitude that determine if something is or is not included as part of our curriculum.

The questions relating to any differences that might exist between urban and rural areas of Newfoundland regarding time spent teaching geometry and attitudes toward geometry failed to reveal any significant differences. It seems that the only difference between the two groups was in teaching experience. This might be due in part to the move by school boards in rural areas of Newfoundland to build large central elementary schools to replace the smaller community schools. These larger schools have attracted well qualified teachers and the discrepancy that at one time existed is now all but eliminated.

One slight difference, although not statistically significant, did occur with regard to attitude scores. While there was little difference in the mean score for the two groups, the standard deviation was different. The rural teachers reported a much higher standard deviation, which would indicate that the scores for this group were more spread out than for the urban group. The difference was such that on a t-test it was found to be significant at the .10 level. Although this level of significance was reported, it was felt that a minimum level of significance of .05 was required to draw any inferences from the results.

A major issue in this study was the question of how many weeks elementary school teachers spend teaching geometry. The ISM mathematics program now in use in the elementary schools indicates a total of seven weeks are required to complete the geometry portion of the program at each grade level. This study revealed that for the school year 1978-1979 elementary school teachers in the province of Newfoundland spent less than one-half this amount of time. A variety of reasons exist for such a low score on the question of time.

One major reason given by elementary teachers to explain why they spend so little time teaching geometry is that they cannot find the time. They claim that the program now in use in the elementary schools is so extensive, that it is difficult to cover all the required topics. Although many elementary teachers like geometry and express their opinions that when they have taught it the children enjoyed it, they cannot find time to work it into their program. Often what the elementary school child receives at any grade level is drill exercises in computation and some exposure to word problems. Geometry was reported by many elementary school teachers to be enrichment exercises, to be done if time permits.

A second reason why geometry has not been given its due in the elementary schools is because until recently almost no attention has been directed to that area of the mathematics curriculum. While the idea of unifying mathematics by introducing geometry into the elementary schools have been around for a number of years, it has been very slow in having any influence of what is actually being taught in the classroom. It is evident from this study that although the appeal has gone out to the schools to take a closer look at what geometry the child needs at the elementary level, this has not materialized into more time being spent on the subject. This may be due, in part at least, to the resistance of teachers to change.

There appeared to be some discrepancy in the percentage of time elementary school teachers felt should be devoted to geometry and the actual amount of time spent. This again reflected the feelings of teachers toward the importance of geometry in the curriculum being overcome by their impressions of what topics should take priority in an elementary mathematics curriculum.

The main question under consideration in this study was the relationship between the attitudes of elementary school teachers toward geometry and the amount of time they spent teaching it. A significant relationship was found to exist. However, the relationship found was a low positive one. This was due to the fact that attitudes were found to be only one of many reasons why little time was spent teaching geometry.

One result from this study which was not surprising was the relationship between teacher experience with certain topics in geometry and how well prepared they felt they were to teach them. Almost without exception, when a teacher reported knowing little or nothing about certain topics, they were very reluctant to teach them. With the exception of measurement and plane geometry, teachers on the whole did not possess much experience with the topics presented and did not feel very well prepared to teach them. Most teachers would require either some personal study in the area or an inservice workshop.

One topic that almost three-quarters of the teachers reported knowing nothing at all about was that of motion geometry. In addition to this, over one-half of the teachers were not prepared at all to teach this aspect of geometry. The geometry program in the ISM mathematics books now being used in our schools present a fair amount of coverage on this topic. This might be one of the reasons teachers are somewhat reluctant to teach certain chapters in the program and complain about the difficulty of the program. Other topics that teachers were very reluctant to teach were symbolic logic, three-dimensional geometry, and coordinate geometry. The fact that only one-third of the teachers indicated that they were fully prepared to teach coordinate geometry might be another reason for so little time being spent on geometry. Between twenty-five and thirty percent of the geometry in the elementary school program is either directly or indirectly related to this topic. This might indicate the area of training most elementary teachers have received in the past. Only recently has emphasis been placed on "non-traditional" geometry for the elementary schools.

Research in mathematics education has indicated on numerous occasions that geometry in the elementary schools should be informal and activity oriented. The results of this study indicated that teachers were inconsistent about the percentage of time spent on geometry in the elementary schools that should be activity oriented. This may be due to two factors. First, most elementary school teachers are resistant to the activity type mode of instruction where the students are not completely under their direct control at all times; and secondly, teachers in the elementary schools are not very familiar with the aids available to help them teach geometry. This is evident from Table X in Chapter IV. Again, this might be one of the reasons teachers have refused to include geometry in their mathematics program.

The approach of the ISM geometry program is basically through the use of manipulative aids. This study found that less than one-quarter of the teachers were using geoboards, and almost half the teachers were not even familiar with them. Such an aid is very useful in teaching many of the concepts in geometry. Equally unfamiliar were such aids as attribute blocks, pattern blocks, tangrams and others. If teachers do not familiarize themselves with such instructional aids, it is questionable whether they will be able to do justice to a program such as the one in the ISM program in use in our elementary schools today.

SUMMARY OF THE DISCUSSION OF RESULTS

The previous discussion has elaborated on the results found in Chapter IV. To briefly summarize these results as discussed in the preceding section, the following results are given in point form:

1. Elementary school teachers do possess a relatively high positive attitude toward geometry but rate it low in priorities when considering a total mathematics program.

2. Far too little time is being spent by elementary school teachers teaching geometry.

3. There does exist a low positive correlation between elementary school teacher attitudes toward geometry and the amount of time spent teaching it.

4. Teachers with little or no experience with certain topics of geometry are very reluctant to teach them.

5. Most elementary school teachers are very unfamiliar with the manipulative aids available to help them with their instruction in geometry.

It is evident that the required time is not being spent on geometry in our elementary schools, and as a result, the children will continue to experience difficulties with geometry at the secondary level.

IMPLICATIONS

The discussion of the results has suggested that attitudes are only one of many factors influencing a teacher's decision to include geometry in an elementary mathematics program or to omit it. Teacher experience, background, and familiarity with certain topics and manipulative aids are some of the other factors that must be taken into consideration.

These results indicate very strongly that geometry is not receiving its due in our elementary schools. The review of literature has indicated that many topics can be learned by our elementary school students without too much difficulty, and that exposure to geometry at the elementary level can benefit the student at the secondary level.

The question of time allocated to mathematical topics such as computation with whole numbers, fractions and decimals, must be looked at very closely to determine if the benefits are such that they cannot be reduced somewhat to provide the necessary time for instruction in geometry.

If more emphasis is to be placed on geometry in the future, teachers must become more familiar with what is required to teach such a program. Inservice workshops similar to those held in the province for the introduction of the metric system might be necessary for the elementary school teachers.

In addition, organized groups such as the Mathematics Special Interest Council of the NTA could very well include in their publication "Teaching Mathematics" information on geometric aids available to help the elementary teacher provide proper instruction in geometry.

While this study has revealed some important information about the status of geometry in our elementary schools today, much remains to be investigated. Some questions that need to be answered by further research are:

(a) What reasons do elementary school children give for not teaching geometry?

(b) Does a relationship exist between how recent a teacher has done a methods course in mathematics education and his/her willingness to include geometry as part of their mathematics program?

(c) What effect would including geometry in the elementary school program have on the overall program as it now exists?

(d) How widespread is the need for an inservice for elementary school teachers in areas of geometry such as transformations?

(e) Should the hand-held calculator reduce the emphasis on computation in the elementary schools, would the teachers be willing to fill the gap with geometry?

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APPENDIX I

MAJOR INSTRUMENT A

This questionnaire is part of the requirements for a Masters Degree in Education. Your careful consideration of the questions will be greatly appreciated.

Thank you.

Name of school ______________________________

Location: (a) Place ______________________________

(b) District ______________________________

No. of years teaching experience ______________

Area of specialization: Major ______________________________

Minor ______________________________

Underline which of the following courses you have completed:

Math 115, Math 1150, Math 1151, Ed. 125, Ed. 2310, Ed. 2320,

Ed. 2340, Ed. 2341, Ed. 3440, Ed. 3441, Ed. 4160, Ed. 4161

Any additional Math or Math Ed. courses completed, please list below:

______________ ______________ ______________

______________ ______________ ______________

______________ ______________ ______________

No. of university courses completed ______________

Grade levels taught last year (circle):

K, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11.

Have you had administrative experience? YES NO

If YES, no. of years ______________

Position ______________

Type of timetable cycle ______________________________

No. of math periods per week ______________

Attitude toward Geometry:

Please read each of the following statements carefully. Put a check mark (✓) in the space provided if you agree with the statement. Put a cross (X) if you disagree with the statement. If you simple cannot decide about a statement, you may place a question mark in the appropriate space.

1. No matter what happens, geometry always comes first ________
2. My parents never had geometry, so I see no merit in it ________
3. Geometry is profitable to everyone who takes it ________
4. Geometry is a waste of time ________
5. I am not interested in geometry ________
6. Geometry has an irresistible attraction for me ________
7. Any student who takes geometry is bound to be benefited ________
8. I look forward to geometry with horror ________
9. I haven't any definite like or dislike for geometry ________
10. Geometry is a good subject ________
11. I am willing to spend my time studying geometry ________
12. I would not advise anyone to take geometry ________
13. All lessons and all methods used in geometry are clear and definite ________
14. Geometry will benefit only the brighter students ________
15. Geometry is a good pastime ________
16. Geometry reminds me about Shakespeare's play - "Much Ado About Nothing" ________
17. I don't believe geometry will do anybody any harm ________
18. I would rather study geometry than eat ________
19. Geometry teaches me to be accurate ________
20. I have no desire for geometry ________
21. Geometry saves time ________

22. It is punishment for anybody to take geometry ________

23. Geometry does not teach you to think ________

24. I love to study geometry ________

25. I am careless in my attitude toward geometry, but I would not like to see this attitude become general ________

26. I hate geometry ________

27. I could do very well without geometry ________

28. Geometry is based on "fogy" ideas ________

29. Geometry is of great value ________

30. I really enjoy geometry ________

31. Geometry is a universal subject ________

32. Mediocre students never take geometry, so it should be eliminated from schools ________

33. I detest geometry ________

34. I have seen no value in geometry ________

35. Geometry is O.K. ________

36. Geometry develops good reasoning ability ________

37. Geometry is not receiving its due in public high schools ________

38. Geometry is very dry ________

39. Geometry is the most undesirable subject taught ________

40. Geometry is very practical ________

41. All of our great men studied geometry ________

42. Geometry is disliked by all students ________

43. The minds of students are not kept active in geometry ________

44. Geometry is a cultural subject ________

45. Geometry is not a bore ________

Underline the answer that best reflects your opinion:

(a) The percentage of time spent on mathematics in the primary (K-3) grades that should be devoted to geometry is:

(1) 0% - 10% (2) 10% - 20% (3) 20% - 30%
(4) 30% - 40% (5) 40% - 50%

(b) The percentage of time spent on mathematics in the elementary (4-6) grades that should be devoted to geometry is:

(1) 0% - 10% (2) 10% - 20% (3) 20% - 30%
(4) 30% - 40% (5) 40% - 50%

(c) The percentage of time spent on mathematics in the junior high (7-9) grades that should be devoted to geometry is:

(1) 0%-10% (2) 10% - 20% (3) 20% - 30%
(4) 30% - 40% (5) 40% - 50%

(d) What percentage of the time spent on geometry in the elementary schools should be activity oriented?

(1) 0% - 10% (2) 10% - 20% (3) 20% - 30%
(4) 30% - 40% (5) 40% - 50%

What is your experience with the following areas of geometry? Circle the number(s) that best represent your answer.

(1) Nothing at all (2) Have read articles or heard talks

(3) Have seen materials (4) Have studied in a course

(5) Have taught

(a)	Motion Geometry (Transformations	1	2	3	4	5
(b)	Measurement:					
(i)	Non-standard units	1	2	3	4	5
(ii)	Standard units	1	2	3	4	5
(iii)	Exactness	1	2	3	4	5
(iv)	Length	1	2	3	4	5
(v)	Perimeter	1	2	3	4	5
(vi)	Area	1	2	3	4	5
(vii)	Volume	1	2	3	4	5
(viii)	Angle	1	2	3	4	5
(c)	Plane (2-dimensional) Geometry					
(i)	Constructions					
	- Compass & straight edge	1	2	3	4	5
	- Mira	1	2	3	4	5
	- Paper folding	1	2	3	4	5
(ii)	Similarity	1	2	3	4	5
(iii)	Congruence	1	2	3	4	5
(iv)	Parallel lines & related angles	1	2	3	4	5
(v)	Symmetry	1	2	3	4	5
(vi)	Open & closed curves	1	2	3	4	5
(vii)	Polygons	1	2	3	4	5
(viii)	Pythagorean theorem	1	2	3	4	5
(d)	Solid (3-dimensional) Geometry					
(i)	Space figures	1	2	3	4	5
(ii)	Relation of lines in space	1	2	3	4	5
(e)	Coordinate Geometry	1	2	3	4	5
(f)	Symbolic Logic	1	2	3	4	5
(g)	Geometry through real life situations	1	2	3	4	5

How well prepared are you to teach the following topics in geometry? Circle one or more.

(1) Fully prepared (2) Need some personal study (3) Need a course or a workshop (4) Need more than a course or two (5) Not prepared at all

(a)	Motion Geometry (Transformations)		1	2	3	4	5
(b)	Measurement:						
	(i)	Non-standard units	1	2	3	4	5
	(ii)	Standard units	1	2	3	4	5
	(iii)	Exactness	1	2	3	4	5
	(iv)	Length	1	2	3	4	5
	(v)	Perimeter	1	2	3	4	5
	(vi)	Area	1	2	3	4	5
	(vii)	Volume	1	2	3	4	5
	(viii)	Angle	1	2	3	4	5
(c)	Plane (2-dimensional) Geometry						
	(i)	Constructions					
		- Compass & straight edge	1	2	3	4	5
		- Mira	1	2	3	4	5
		- Paper folding	1	2	3	4	5
	(ii)	Similarity	1	2	3	4	5
	(iii)	Congruence	1	2	3	4	5
	(iv)	Parallel lines & related angles	1	2	3	4	5
	(v)	Symmetry	1	2	3	4	5
	(vi)	Open & closed curves	1	2	3	4	5
	(vii)	Polygons	1	2	3	4	5
	(viii)	Pythagorean theorem	1	2	3	4	5
(d)	Solid (3-dimensional) Geometry						
	(i)	Space figures	1	2	3	4	5
	(ii)	Relation of lines in space	1	2	3	4	5
(e)	Coordinate Geometry		1	2	3	4	5
(f)	Symbolic Logic		1	2	3	4	5
(g)	Geometry through real life situations		1	2	3	4	5

The following are some materials available to aid in the teaching of geometry. How do you realte to those materials. Circle the appropriate response.

1. Are presently using or have used.
2. Would like to use but are not available.
3. Are available but do not use.
4. Not available and would not use if they were.
5. Not familiar with.

1.	Geoboards	1	2	3	4	5
2.	Mira	1	2	3	4	5
3.	Attribute Blocks	1	2	3	4	5
4.	Pattern Blocks	1	2	3	4	5
5.	Geo-strips (straws)	1	2	3	4	5
6.	Tangrams	1	2	3	4	5
7.	Pentominoes	1	2	3	4	5

If you have circled 1 for any of the above, explain what they are being used for:

____

____

____

____

____

____

____

Rank (1-15) the following topics in the order of importance as you see them for an elementary school math curriculum.

_____ Measurement

_____ Place value

_____ Whole number computation

_____ Number theory

_____ Graphing

_____ Problem solving

_____ Geometry

_____ Estimation

_____ Equation solving

_____ Consumer math

_____ Probability

_____ Integers (positive & negative numbers)

_____ Fractions & Operations

_____ Decimals & Operations

_____ Set theory

APPENDIX II

INSTRUMENT B

GRADE 3

CHECK LIST FOR GEOMETRY IN ISM

Chapter 1 (Counting & Measurement)

	Topic	Covered	Not Covered
(i)	Length & width using non-standard linear lengths	________	________
(ii)	Construction of child's own unit of measure & usage	________	________
(iii)	Standard units of measure (metric)	________	________
(iv)	Comparison of units of measure	________	________
(v)	Exactness of measure	________	________
(vi)	Area through measurement (counting)	________	________
(vii)	Area of simple geometric shapes using halves and fourths	________	________
(viii)	Volume through measurement (counting)	________	________
(ix)	Word problems involving measurement	________	________

Time spent on Chapter 1
/number of periods ________

Chapter 4 (Geometry)

	Topic	Covered	Not Covered
(i)	Recognition of flat & curved surfaces, straight & curved edges and vertices, given a 3-dimensional object	________	________
(ii)	Identify points, rays, line segments, lines & planes	________	________
(iii)	Connecting points to form line segments	________	________
(iv)	Recognition of angles (right and others)	________	________
(v)	Construction of right angles by paper folding	________	________
(vi)	Identifying and drawing triangles	________	________
(vii)	Recognition of right angles	________	________
(viii)	Sum of the angles of a triangle through paper cutting	________	________
(ix)	Identify parts of right triangle	________	________
(x)	Informal introduction to the Pythagorean Theorem	________	________

Time spent on Chapter 4
/number of periods ________

Chapter 8 (Geometry)

	Topic	Covered	Not Covered
(i)	Identify & draw parallel lines	________	________
(ii)	Identify equal angles when parallel lines are cut by transversal	________	________
(iii)	Identify a quadrilateral	________	________
(iv)	Identify regular quadrilaterals	________	________
(v)	Divide parallelogram into two congruent triangles	________	________
(vi)	Construct (paper folding) a parallelogram from a quadrilateral	________	________
(vii)	Identify diagonals of polygon	________	________
(viii)	Recognition of simple closed curves	________	________
(ix)	Construction (paper folding) of figures that are symmetrical	________	________

Time spent on Chapter 8
/number of periods ________

Chapter 11 (Geometry & Graphing)

Topic	Covered	Not Covered
(i) Given coordinates on a graph join points with line segments to make a picture	______	______
(ii) Symmetrical figures on a graph	______	______
(iii) Translations (slides) of a figure on a graph	______	______

Time spent on Chapter 11
/number of periods ________

Total number of periods spent teaching geometry	________
Total number of periods spent teaching math	________
Percentage of total time spent teaching math, spent teaching geometry	________

GRADE 4

CHECK LIST FOR GEOMETRY IN ISM

Chapter 1 (Numbers & Measurement)

	Topic	Covered	Not Covered
(i)	Measurement of length of a strip using a second strip as a unit	________	________
(ii)	Measurement of objects using a centimeter ruler	________	________
(iii)	Estimation of length	________	________
(iv)	Fractional unit measurement	________	________
(v)	Exactness (half cm or cm)	________	________
(vi)	Perimeter through measurement	________	________
(vii)	Area by counting number of units	________	________
(viii)	Area by measurement	________	________
(ix)	Fractional measure of area	________	________
(x)	Volume by counting	________	________
(xi)	Volume by measurement	________	________
(xii)	Conversion of metric units	________	________

Time spent on Chapter 1
/number of periods ________

Chapter 4 (Geometry)

	Topic	Covered	Not Covered
(i)	Construction of cube through paper folding	______	______
(ii)	Identify edges, faces and vertices of a cube	______	______
(iii)	Distinguishing between patterns that do or do not form cubes	______	______
(iv)	Break-down of cube into points, angles & segments	______	______
(v)	Find examples of points, lines, segments, rays, and angles	______	______
(vi)	Identify parallel lines	______	______
(vii)	Draw parallel lines, segments, parallelograms, rectangles, and rhombi (paper folding)	______	______
(viii)	Construct triangular pyramid from pattern	______	______
(ix)	Identify edges, faces and vertices of triangular pyramid	______	______
(x)	Identify simple closed curves	______	______
(xi)	Determine whether points are inside or outside a closed curve	______	______
(xii)	Construct quadrilaterals (geo-strips)	______	______
(xiii)	Draw pictures of simple polygons	______	______
(xiv)	Determination of symmetry through paper folding	______	______

Time spent on Chapter 4

/number of periods ________

Chapter 9 (Geometry)

	Topic	Covered	Not Covered
(i)	Classification of cylindrical or conical objects	✓	
(ii)	Identify parts of a circle	✓	
(iii)	Draw circles using compass, round object or two pencils and paper clip		
(iv)	Tangent to a circle		
(v)	Inscribe a circle in a triangle		
(vi)	Congruent figures (recognition)		
(vii)	Construction of congruent figures through paper folding		

Time spent on Chapter 9
/number of periods ________

Chapter 13 (Geometry & Graphing)

	Topic	Covered	Not Covered
(i)	Making a picture by joining coordinate points	______	______
(ii)	Symmetry	______	______
(iii)	Expansion of contraction of a given figure	______	______
(iv)	Translation of figure	______	______

Time spent on Chapter 13
/number of periods ________

Total number of periods spent teaching geometry ________

Total number of periods spent teaching math ________

Percentage of time spent teaching geometry ________

GRADE 5

GEOMETRY IN THE ISM PROGRAM

Chapter 4 (Geometry & Measurement)

	Topic	Covered	Not Covered
(i)	Identify point, line, ray, and segment and use symbols to table them	______	______
(ii)	Identify congruent segments	______	______
(iii)	Measurement of segment	______	______
(iv)	Identify parallel and intersectory lines	______	______
(v)	Name angles using standard notation	______	______
(vi)	Identify congruent angles	______	______
(vii)	Measurement of angles in terms of unit angle	______	______
(viii)	Make and use protractor	______	______
(ix)	Name types of triangles	______	______
(x)	Congruence tested by tracing	______	______
(xi)	Form polygonial shapes using tangrams	______	______
(xii)	Perimeter of polygons	______	______
(xiii)	Area of polygons	______	______
(xiv)	Area of triangle	______	______

Time spent on Chapter 4
/number of periods ______

Chapter 13 (Geometry & Measurement II)

	Topic	Covered	Not Covered
(i)	Recognition of 3-dimensional figures as geometric shapes	______	______
(ii)	Match physical objects with geometric shapes	______	______
(iii)	Construct geometric shapes by paper folding	______	______
(iv)	Draw 3-dimensional figures	______	______
(v)	Volume (rectangular prism)	______	______
(vi)	Surface area (rectangular prism)	______	______
(vii)	Volume and surface area by measurement	______	______
(viii)	Points of view of 3-dimensional objects	______	______
(ix)	Faces, vertices and edges of geometric solid	______	______

Time spent on Chapter 13
/number of periods ________

Chapter 15 (Graphing & Geometry)

Topic		Covered	Not Covered
(i)	Graphing coordinate points on a plane	______	______
(ii)	Symmetrical figures	______	______
(iii)	Reflection	______	______
(iv)	Rotations	______	______
(v)	Translations	______	______
(vi)	Similarity of figures in a coordinate plane	______	______
(vii)	Tessellations	______	______

Time spent on Chapter 15
/number of periods ________

Total number of periods spent teaching geometry ________

Total number of math periods ________

Percentage of time spent teaching geometry ________

GRADE 6

Chapter 4 (Geometry & Measurement I)

	Topic	Covered	Not Covered
(i)	Identify point, ray, line, segment, plane, angle, and triangle from words, symbols or pictures	________	________
(ii)	Construct 3-dimensional figures from diagrams	________	________
(iii)	Match geometric figures with physical objects	________	________
(iv)	Different views of parts of 3-D figures	________	________
(v)	Identify parallel and perpendicular lines	________	________
(vi)	Basic constructions	________	________
(vii)	Congruence (tracing paper)	________	________
(viii)	Measurement in cm	________	________
(ix)	Measure angle using protractor	________	________
(x)	Identify different types of triangles	________	________
(xi)	Symmetry through folding	________	________
(xii)	Tessellations	________	________
(xiii)	Recognize and construct regular polyhedrons	________	________
(xiv)	Intersection of plane with space figure	________	________

Time spent on Chapter 4

/number of periods ________

Chapter 11 (Geometry & Measurement II)

Topic		Covered	Not Covered
(i)	Approximate measure of length of simple curve	______	______
(ii)	Perimeter by sum of its sides	______	______
(iii)	Circumference of circle applying the formula	______	______
(iv)	Area of rectangle and parallelogram	______	______
(v)	Area of triangle	______	______
(vi)	Pythagorean Theorem	______	______
(vii)	Area of circle using formula	______	______
(viii)	Volume of rectangular prism	______	______
(ix)	Surface area of rectangular prism	______	______
(x)	Problem solving	______	______

Time spent on Chapter 11

/number of periods ________

Chapter 12 (Geometry & Graphing)

	Topic	Covered	Not Covered
(i)	Reflections in a plane	________	________
(ii)	Rotations	________	________
(iii)	Rotational symmetry	________	________
(iv)	Translations (images)	________	________
(v)	Tessellations	________	________
(vi)	Similar triangles	________	________
(vii)	Magnification	________	________

Time spent on Chapter 12
/number of periods __________

Total number of periods spent on geometry in grade 6 __________

Total number of periods spent on math in grade 6 __________

Percentage of time spent on geometry in grade 6 __________

APPENDIX III

SCORE VALUE OF ATTITUDE STATEMENTS USED

IN INSTRUMENT A

ATTITUDE TOWARD ANY SCHOOL SUBJECT

Form A

Scale Values	Statement
10.3	No matter what happens, this subject always comes first.
10.2	I would rather study this subject than eat.
9.8	I love to study this subject.
9.7	This subject is of great value.
9.6	This subject has an irresistible attraction for me.
9.4	I really enjoy this subject.
9.2	This subject is profitable to everyone who takes it.
9.1	This subject develops good reasoning ability.
9.0	This subject is very practical.
8.9	Any student who takes this subject is bound to be benefited.
8.8	This subject teaches me to be accurate.
8.7	This subject is a universal subject.
8.5	This subject is a good subject.
8.4	All of our great men studied this subject.
8.3	This subject is a cultural subject.
8.1	All lessons and all methods used in this subject are clear and definite.
7.9	This subject is O.K.
7.7	I am willing to spend my time studying this subject.
7.6	This subject is not receiving its due in public high schools.
7.3	This subject saves time.
6.8	This subject is not a bore.
6.5	This subject is a good pastime.

Scale Value	Statement
6.1	I don't believe this subject will do anyone any harm.
5.8	I am careless in my attitude toward this subject, but I would not like to see this attitude become general.
5.5	I haven't any definite like or dislike for this subject.
4.7	This subject will benefit only brighter students.
3.6	My parents never had this subject, so I see no merit in it.
3.5	I could do very well without this subject.
3.4	Mediocre students never take this subject, so it should be eliminated from schools.
3.3	The minds of students are not kept active in this subject.
3.1	I am not interested in this subject.
2.9	This subject does not teach you to think.
2.8	This subject is very dry.
2.6	This subject reminds me about Shakespeare's play - "Much Ado About Nothing."
2.5	I have no desire for this subject.
2.4	I have seen no value in this subject.
2.2	I would not advise anyone to take this subject.
2.1	This subject is based on "fogy" ideas.
1.6	This subject is a waste of time.
1.5	It is a punishment for anybody to take this subject.
1.3	This subject is disliked by all students.
1.0	I look forward to this subject with horror.
0.8	I detest this subject.
0.7	This subject is the most undesirable subject taught.
0.6	I hate this subject.

APPENDIX IV

SUMMARY OF RESEARCH ON GEOMETRY BY WILLIFORD

One of the most complete reviews on geometry is that done by Williford (1972). His references include almost forty dissertation and research reports. The major findings of Williford (1972) were:

1. The research indicated that a majority of very young children possess a variety of geometric skills involving the identification and matching of planar and solid figures, the comparison of linear measurements, and the reproduction of parallel and perpendicular segments. At around age twelve, the ability to represent planar sections of solid figures develops. A survey of text materials reveals that in the upper elementary grades the emphasis on geometry has increased greatly since the turn of the century. Furthermore, students exposed to modern programs appear to learn more geometry than those students in more traditional programs.

2. Several studies reported that, at least for programmed instruction, concentrated teaching (longer sessions and more sessions each week) produces better attitudes but poorer achievement than does more dispersed instruction. However, the finding that geometry classes taught by teachers achieve more than those taught through programmed instruction indicates that perhaps such results may not be characteristic of regular classes. Research also implies that many concept examples lead to better understanding of geometric concepts than do fewer concept examples at the kindergarten level, but with older children more numerous concept examples do not seem necessary. Similarly, paper folding proved superior to mirrors in teaching symmetry to kindergarten subjects, but at higher grade levels paper-folding techniques were no better than other methods in teaching symmetry or the

construction of solids. Apparently, kindergarten children learn geometric concepts better through manipulative activity with numerous examples. Other research concluded that the use of a large amount of concrete materials was better than a moderate or minimum amount in the middle elementary grades. Furthermore, expository methods appear superior to discovery methods in producing short-term retention, whereas discovery methods are better than expository methods in stimulating long-term retention.

3. Research has noted a significant relationship between success in geometry and general reading and mathematics achievement. Such a finding is not totally unexpected. Some investigators anticipated a transfer effect of geometry instruction to other mental capacities. Generally, for the studies of this review, no such transfer was noted, although high-IQ fifth graders who were taught coordinate geometry did show significant gains on a test of map and graph understandings.

4. There is evidence that the geometric knowledge of elementary school pupils is significantly related to their teacher's knowledge. Another investigation noted that, for the most part, prospective elementary teachers perform poorly on a test measuring their knowledge of elementary school geometry. Perhaps one way to improve pupil knowledge of geometry is to improve teacher knowledge. Other research that attempted to identify factors related to teacher knowledge noted that the number and type of previous mathematics courses, especially high school geometry, are associated with geometric knowledge of both prospective and inservice teachers. In geometry classes for prospective teachers, classes including activities of the laboratory type

were no more effective than classes without such activities.

5. Finally, a number of investigations proved that a variety of geometric topics can be taught to elementary school children. Such topics include aspects of topology, motion geometry, coordinate geometry, and simple geometry constructions and bisections. Although these topics are primarily of an experimental nature, the evidence indicates that they can indeed play a more prominent role in the elementary curriculum.